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A DESCRIPTION OF IMPERIAL VALLEY, CALIFORNIA FOR THE ASSESSMENT OF IMPACTS OF GEOTHERMAL ENERGY DEVELOPMENT

David Layton
Donald Ermak

August 26, 1976

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A DESCRIPTION OF IMPERIAL VALLEY, CALIFORNIA FOR THE ASSESSMENT OF IMPACTS OF GEOTHERMAL ENERGY DEVELOPMENT

Preface

This report is part of a research effort at the Lawrence Livermore Laboratory known as the Imperial Valley Environmental Project. It is sponsored by the Assistant Administrator for Environment and Safety of the U.S. Energy Research and Development Administration. The project is designed to ensure that the development of geothermal resources proceeds on an environmentally sound basis. To carry out that objective, the project includes the following research groups: Air Quality, Ecosystem Quality, Water Quality, Subsidence and Seismicity, Health Effects, Socioeconomic Effects, and Integrated Assessment. The background research providing descriptive material on the valley was done under the auspices of the Integrated Assessment group whose special research responsibilities include the evaluation of relevant environmental impacts, the development of alternative geothermal scenarios, data management, and the timely transfer of information to decision makers.

Abstract

Impending geothermal development in the Imperial Valley of California has raised concern over the possible impacts of such development. As an initial step in impact assessment of geothermal projects, relevant features of the valley's physical and human environments are described. Particular attention is placed on features that may either influence development or be affected by it. Major areas of consideration include the valley's physical resources (i.e., land, air, water, and biological resources), economic, fiscal, and social characteristics of Imperial County, and geothermal laws.

Section 1
Introduction and Summary

A warm climate, good soils, and imported water combine to make the Imperial Valley of California a place of intense agricultural activity. And now, with increased interest in the geothermal resources underlying the valley, the area faces the prospect of a new industry for the production of electricity, and perhaps water, from geothermal fluids. The development of geothermal resources, nevertheless, will be accompanied by various impacts on the valley's physical and human environments that must be carefully identified and assessed. Sections 2 through 5 of our report describe the valley's natural resources; Sections 6 through 8 review economic, fiscal, and social characteristics of Imperial County; and Section 9 describes geothermal laws that may affect geothermal projects. The principal features of the valley presented in these sections are summarized below.

LAND AND AIR RESOURCES

The Imperial Valley occupies the lowest part of the Colorado Desert. It receives water from the Colorado River to support about 475,000 acres of irrigated lands. The waste waters from these lands help sustain the Salton Sea, California's largest inland body of water. Geologically the valley is characterized by earthquakes, active faults, and natural subsidence. Hot summers, mild winters, and an average annual rainfall of under 3 inches define its climate; stable atmospheric conditions, westerly winds, and night time inversions are important meteorological features. The most prominent characteristic of the air quality is the high levels of suspended particles that exceed federal standards.

WATER RESOURCES

Nearly 3 million acre-feet (af) of Colorado River water are diverted to the valley each year by the Imperial Irrigation District. To distribute that water and remove unwanted waste waters, over 3,000 miles of canals and drainage ditches cover the valley. Waste waters entering the Salton Sea have caused its level to rise for many years, and the sea is now at its highest elevation in recent years. Surface water salinity ranges from about 900 ppm total dissolved solids (TDS) in the All American Canal to almost 39,000 ppm in the Salton Sea. Sediments underlying the valley contain more than a billion acre-feet of ground water having salinity

less than 35,000 ppm. Natural recharge in this arid region is quite low, yet millions of acre-feet have been added to shallow aquifers from canal seepage.

BIOLOGICAL RESOURCES

There is an extensive, irrigated agricultural region, a quasi-marine inland saltern ecosystem, state and federal game reserves with many shorebirds and waterfowl, five endangered species of birds, freshwater and riparian ecosystems, and extensive desert communities in the Imperial Valley. Agricultural lands produced gross sales in 1974 of $557 million of which $155 million was in livestock and dairy products, $284 million in field crops, and $103 million in vegetable crops. In acreage harvested, the most important crops are alfalfa, wheat, cotton, sugar beets, lettuce, sorghum, pasture ryegrass, cantaloupes, carrots, barley, asparagus, onions, and tomatoes. The unique climate is such that most vegetable crops grow in the winter months and most field crops grow in the spring and summer months. Soil salinity problems are important in the valley and require large amounts of Colorado River water for leaching and an extensive underground pipe drainage system to carry off water and dissolved salts. The leached salts are eventually emptied into the Salton Sea. Of the many attempts to introduce new species into the Sea, only a few have been successful. Currently there are eight fish and seven invertebrate species. The sea has high levels of nutrients that create an unusually high productivity (0.75 g/m^3/day of carbon fixation). Extensive shorebird (35 species) and waterfowl (47 species) (excluding swans, ducks, geese, cranes, and rails) populations exist around the Salton Sea especially in the state and federal game refuges. The Salton Sea is on the Pacific Flyway and hosts large migratory populations (a total of 9.7 million waterfowl use days in 1971 for the Salton Sea National Wildlife Refuge). Outside the irrigated areas in the Valley lies the Sonoran Desert. Typical desert communities of creosote brush, sage, mesquite, ironwood, and desert willow dominate the Glamis, East Mesa, and Dunes Known Geothermal Resource Areas (KGRAs). In these KGRAs some areas are dominated by dune communities of very sparse vegetation and a shifting, sandy soil. The balance of the area in these KGRAs is mixed bajada (alluvial fan) communities or creosote communities.

GOETHERMAL RESOURCES

As early as 1927, efforts were made to develop the geothermal resources in the Imperial Valley. Mineral extraction, carbon dioxide

recovery, and power production have all been attempted, but with limited success. Some of the current geothermal activities are electric power conversion research, impact studies of proposed geothermal projects, baseline environmental studies, and exploratory drilling. Of the 6 KGRAs, only the Salton Sea, Heber, East Mesa, and Brawley areas are expected to be developed. Estimates of their total electrical potential are under 5,000 MW for 30 years. The Salton Sea KGRA has the greatest energy potential because of its high down-hole temperatures (average of 286°C), yet it may be the hardest to develop since brines found there average over 200,000 ppm TDS. In comparison, the Heber KGRA has geothermal fluids of around 20,000 ppm TDS, while those of the East Mesa KGRA are about 2,100 ppm TDS. Other relevant characteristics of the geothermal fluids in the valley include a steam content of between 10 to 25% by weight and the presence of minor amounts of non-condensable gases.

COUNTY ECONOMIC CHARACTERIZATION

The Imperial County economy is dominated by agriculture, its associated support services, and product processing. Agricultural activities are dominated by beef cattle and by general field crops. In 1974, 85.9% of the total valley acreage was planted in field crops with a total dollar value of $284 million. There was a decline in beef production in 1974 with 720,000 head raised in valley feed lots (down from 798,000 in 1973) with a total value of $151 million (down from $186 million in 1973). While strong in the agricultural sectors, the Imperial County economy is weak in manufacturing and construction activity compared to the state as a whole. Recent county employment patterns show a steady decline in agricultural employment (down 48% between 1960 and 1970) as agriculture has become more mechanized. During the same time, a steady increase occured in nonagricultural employment. Mexican greencard labor represents under 2% of the county nonagricultural employment and roughly 70% of the agricultural work force. Within the county, El Centro is the industrial, commercial, and general economic center representing well over half of all county retail sales. A second significant center is Calexico, which is located on the U.S.-Mexico border and serves both Imperial County and Mexican markets.

COUNTY FISCAL CHARACTERIZATION

The Imperial County budget for fiscal year 1976 totaled $38.7 million for a per capita budget of $519.8. About 25% of the county's

revenues that year came from the federal government, and a second 25% came from the state of California. Income from local taxes and fines accounted for 26.5% of the county's income. The remainder of fiscal 1976 income was derived from carry-over and service charges.

During the fiscal year, $30.8 million was spent on education by the school districts. The average cost per year per student in an elementary school was $1,220, while that of a secondary school student was $1,385. These figures have increased over the past decade by 110% for secondary education and by 170% for elementary education.

COUNTY SOCIAL CHARACTERIZATION

The 1974 population of Imperial County is estimated to be just under 84,000; the 1970 official census figure was 74,492. Approximately 95% of the population is concentrated on the agriculturally rich land of Imperial Valley. The 1970 census reveals major characteristics of this population: an unusually low percentage of young adults (ages 18 to 24); a high percentage of children under 13 yr old; a large number of Mexican-Americans, as would be expected of a border county; the highest percentage of any California county of adults with minimal educational attainment (less than an 8th grade education); and, finally, income levels comparable to most other California counties.

GEOTHERMAL LAWS

Statutes and regulations made at federal, state, and county levels have a strong influence on the development of geothermal resources in the Imperial Valley. The Geothermal Steam Act of 1970 governs the leasing of federal lands for geothermal projects. Important conditions of the Act are an acreage limitation on leases and the exemption of federal lands related to the protection of wildlife. Regulations promulgated under the legislation are designed to protect the environment as much as possible from the effects of geothermal development. The federal government also operates a loan guaranty program for geothermal projects. California statutes directly associated with geothermal resources control the leasing of state lands and the drilling of geothermal wells. Certification of geothermal power-plants is done by the state's Energy Resources Conservation and Development Commission. Imperial County also has regulations that involve geothermal activities. Those regulations ensure that geothermal projects are conducted in a manner that is consistent with existing environmental laws and regulations, county land use zones, and other specific conditions.

Section 2
Land and Air Resources

Donald Ermak, Mary Buchanan, and David Layton

2.1 GEOGRAPHICAL OVERVIEW

The Imperial Valley-Salton Sea areas are part of the arid Colorado Desert located in southeastern California (see Fig. 2.1). The Colorado Desert, however, contains only 2,500 square miles and represents but one of the six major divisions of the vast Sonora Desert that includes southeastern California as well as generous portions of Sonora (Mexico), southern Arizona, and northeastern Baja California (Mexico). The combined areas consist of some 120,000 square miles that surround much of the Gulf of California. Although most of the Sonora Desert divisions have much in common, the Colorado Desert is characterized by its lower inland elevations and an increased water supply from the Colorado River. The north and west boundaries are provided by the Mojave Desert and the Peninsular Range. Included in the Peninsular Range are the San Jacinto and Santa Rosa Mountains in Southern California. The Palo Verde and Coachella Valleys are also part of the Colorado Desert. Except for its Baja California portion, this desert is completely land-locked, separated from the Pacific Coast by a large mountain mass, itself containing several valleys.[1] At 273 feet below sea level, the Salton Sink in the Imperial Valley is the lowest elevation in the Colorado Desert while in the surrounding mountains, elevations may reach several thousand feet.[2] Drainage from the low, scattered mountains situated in the eastern portion of the desert flows to the Colorado River and into the Coachella and Imperial Valleys, which have no outlet to the Gulf of California.

In contrast to the arid lands of the Colorado Desert are the verdant agricultural lands of the Imperial Valley. These lands are irrigated with water imported from the Colorado River via the All American Canal. Within the irrigated portion of the valley the lands are essentially privately owned; and outside the central part of the valley are federal lands managed by the Bureau of Land Management.[2,3] Wildlife management areas and recreational sites near the Salton Sea constitute other land uses of note.[3]

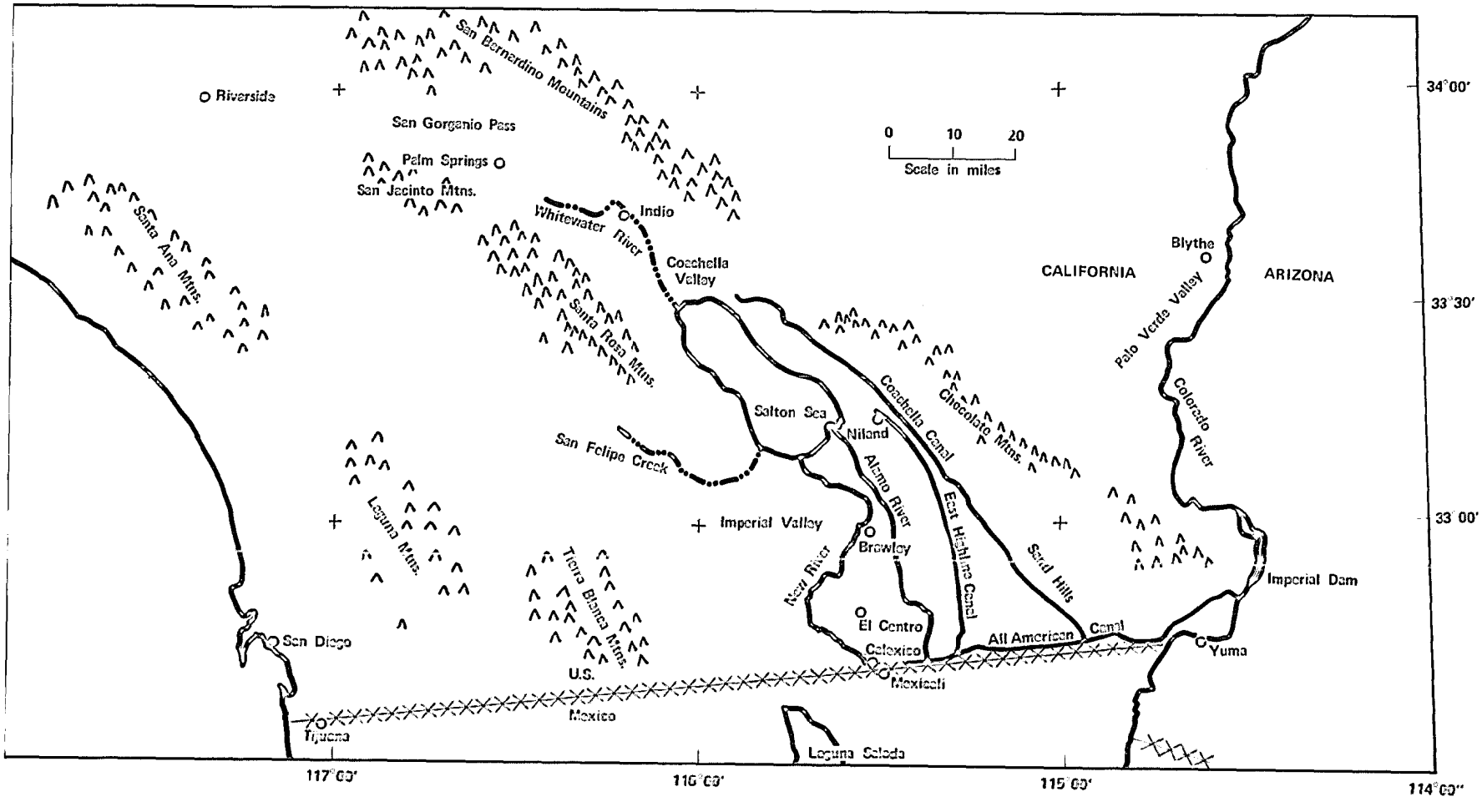

Fig. 2.1. Southeastern California.

2.2 GEOLOGY

The Imperial Valley occupies part of a rift valley known as the Salton Trough. This trough extends from the Gulf of California to the northern segment of the Coachella Valley. It is 200 km long, between 5 and 130 km wide,[4] and has a maximum sedimentary thickness of about 6 km above basement rock.[5] Major sedimentary facies include deltaic, lacustrine, alluvial, and aeolian deposits. Current tectonic processes are manifested in the basin by active faults, natural subsidence, and earthquakes. Volcanic activity is also associated with parts of the trough.

Sedimentary Rocks

Sediments in the trough overlay basement rocks consisting of Mesozoic metamorphic rocks that have been intruded by plutonic rocks.[6] Nonmarine deposits from the Colorado River dominate the stratigraphy of the basin, but sediments of marine origin like the Imperial Formation are present as well. An oil test well drilled to a depth of over 13,000 ft in the central portion of the Imperial Valley indicates that the stratigraphic column is made up of fine grained sandstones and siltstones having chemical characteristics similar to those of the present day Colorado River Delta.[5]

Recent lacustrine sediments deposited by prehistoric Lake Cahuilla covers the greatest area in the valley (see Fig. 2.2) and are composed of silts, sands, and clays. The alluvium bordering the mountains that enclose the valley contains silts, sands, and gravels that decrease in size into the finer lacustrine sediments found in the central portion of the valley.[4] Aeolian sands constitute another major facies. The largest deposit in the Salton Trough is known as Sand Hills. The dunes, that exist as parallel waves, are migrating to the southeast under the control of westerly winds.[4]

Structure and Tectonics

A significant feature of the regional geology is the major strike-slip faults exhibiting right lateral movement. Important faults in the Imperial Valley are the San Andreas, Imperial, San Jacinto, and the Elsinore Faults.[7] One of the more active faults, the Imperial, had almost 2 m lateral displacement during the years 1934 to 1967.[8] Natural subsidence is occurring in the middle of the valley, while

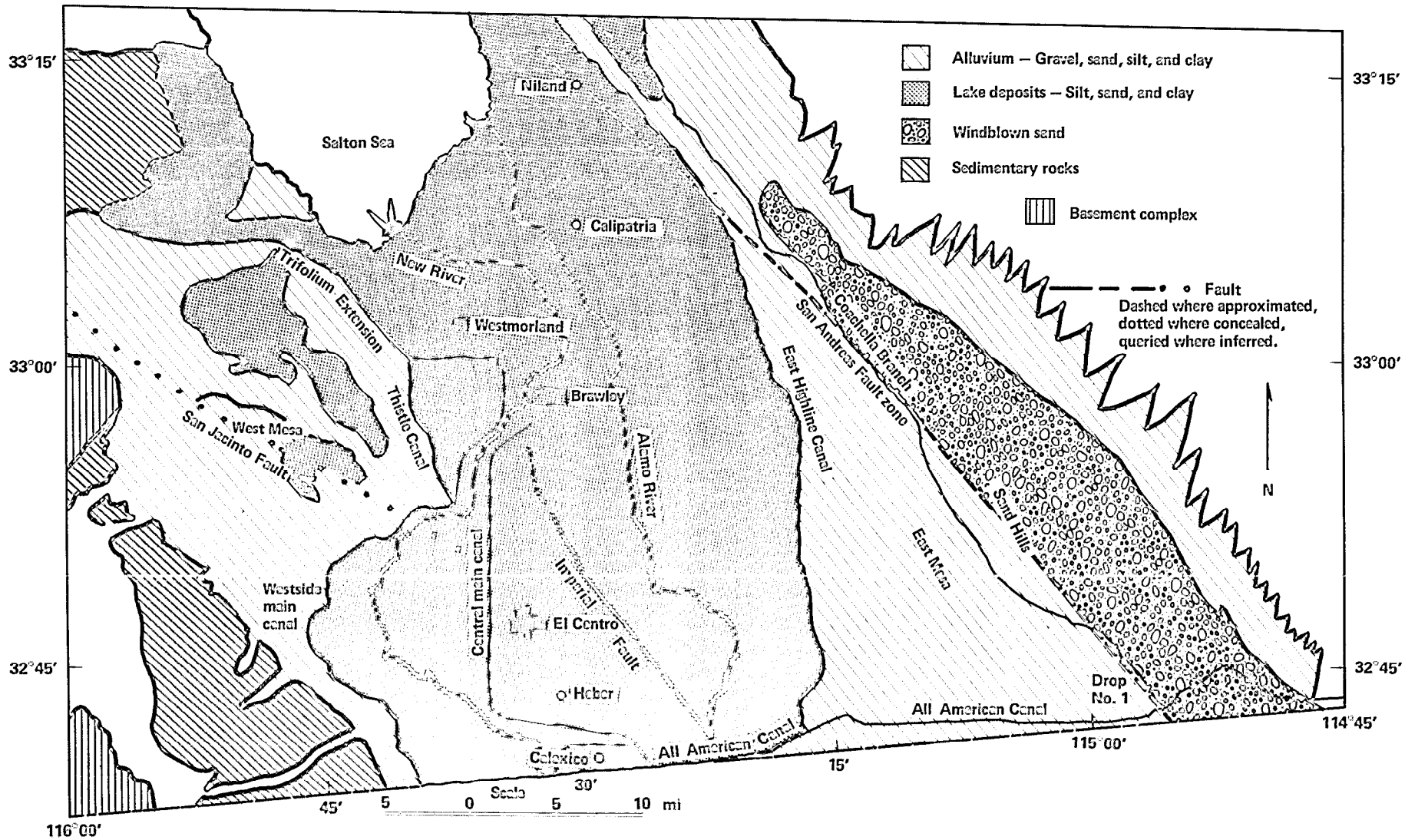

Fig. 2.2. Generalized geologic map of the Imperial Valley.[6]

uplift occurs along the valley sides. Measurements of subsidence taken from 1931 to 1941 revealed downward movements as much as 10 to 20 cm.[8]

Crustal displacements in the valley have been accompanied by a great deal of seismic activity. As many as 12 earthquakes of 6.0 or higher on the Richter scale have hit the Salton Trough in this century.[7] In addition to the higher magnitude quakes, many earthquakes below a magnitude of 5.0 occur in earthquake swarms. A review of seismic patterns in the Imperial Valley by Hill, et al.[9] revealed the following characteristics:

- A linear alignment of epicenters in the middle of the valley corresponding to the northern part of the Imperial Fault,
- A second concentration of epicenters in the Brawley area,
- An infrequency of earthquakes to the east of the Imperial Fault, and
- Depths of most of the quakes between 5 and 14 km.

The structural and tectonic characteristics of the Imperial Valley as well as its geothermal anomalies can be explained through plate tectonics and ocean floor spreading. A portion of the earth's crust defined by the Pacific plate is moving in a northwest direction with respect to the American plate.[10] The main boundary between the two plates is the San Andreas fault zone, part of which passes through the valley. Close to the boundary, earthquakes occur that reflect the crustal movements of the two plates. Spreading centers - areas where the earth's crust is pulling apart forming tension cracks along which lava rises towards the surface - are another possible source of earthquakes.[10] Moreover, such spreading centers may account for the valley's geothermal anomalies and volcanism.[8,10]

2.3 CLIMATE

The Imperial Valley has a desert climate with hot, dry summers and mild winters. Data on average temperatures for the last 62 years are displayed in Fig. 2.3. The average temperature in January is about 55°F, whereas in July it is about 90°F. This large seasonal temperature difference is indicative of the continental character of the valley's climate. The absence of marine influences is due to high mountain ranges that separate the valley from the California coast. Average diurnal temperature ranges are 20 to 30°F throughout the year.

Precipitation in the Imperial Valley is very low as shown in Fig. 2.4. The rainy season is from August through March, during which

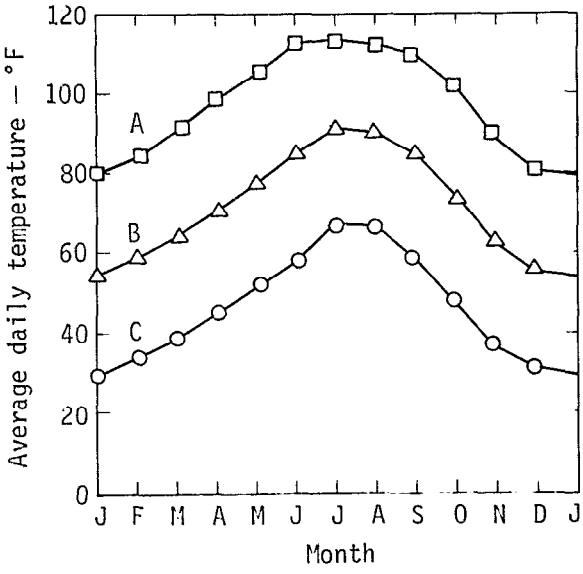

Fig. 2.3. The average daily temperature in Imperial Valley for each month of the year. A = average maximum temperature; B = average temperature; C = average minimum temperature.[11]

there is an average of a little over 3 hr rainfall/mo. June is the driest month with measurable rainfall occurring only once (0.04 in. on June 2, 1948) since 1914.[12] The average yearly rainfall is 2.73 in. Yearly averages may be misleading, however, as there is considerable variation in rainfall from year to year as shown in Fig. 2.5. Yearly rainfall has varied from a fraction of an inch to over 8 in. The valley has little fog and few thunderstorms. The only recorded snowfall of consequence occurred on December 12, 1932, when 2-1/2 to 4 inches fell throughout the valley. Humidity is very low, especially in the summer. Figure 2.6 shows the average relative humidity for the year 1975.

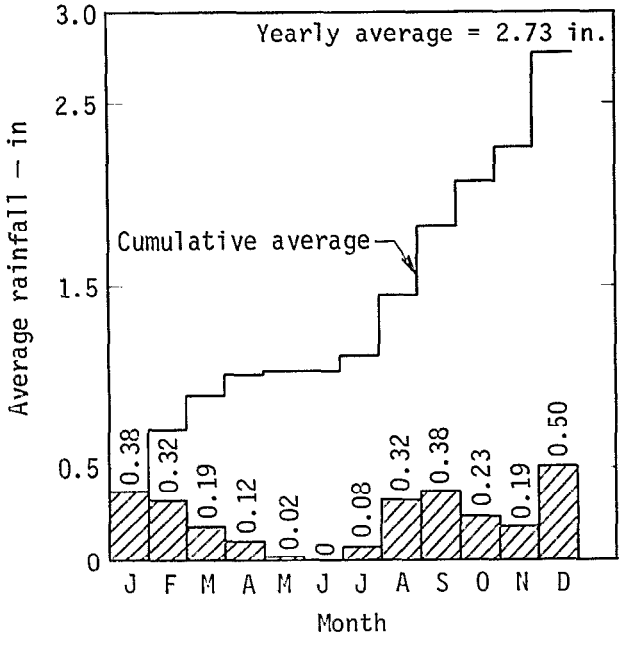

Fig. 2.4. The average monthly rainfall in Imperial Valley. The cumulative average is also shown.[11]

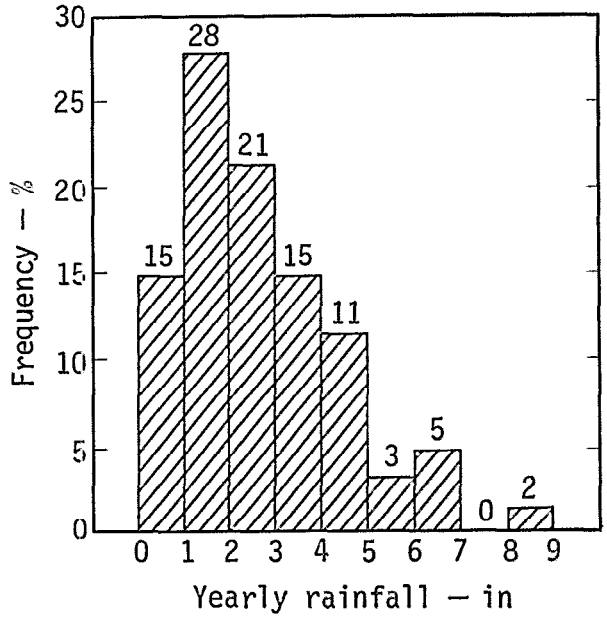

Fig. 2.5. Total yearly rainfall in Imperial Valley.[11]

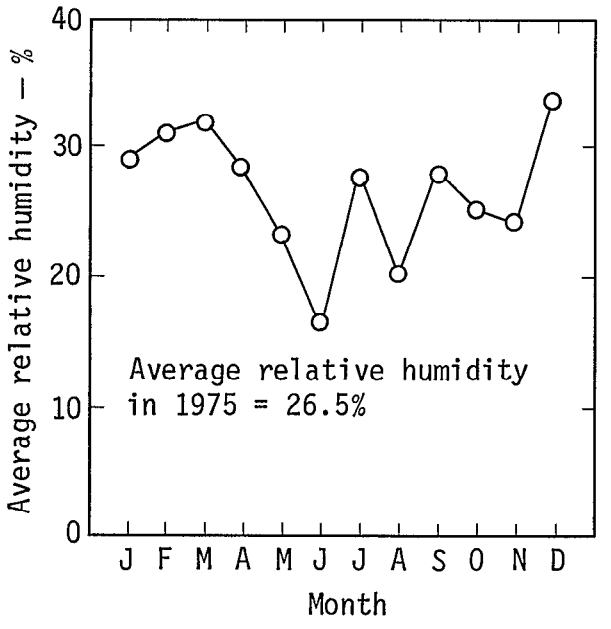

Fig. 2.6. The average relative humidity in the Imperial Valley during 1975.[12]

Imperial Valley lies in the southeastern part of the California southeast desert basin. A description of the seasonal variations of this region is given by Bennett,[13] a summary of which follows. In the winter, the basin is generally covered by a moderately intense anticyclonic circulation, except during periods of frontal activity. An average of 20 to 30 frontal systems move into the northern part of the California southeast desert basin each winter. They are relatively weak and become more diffuse as they move southward into the Imperial Valley. Most of the precipitation is associated with these frontal systems. The valley is protected to a large degree from the cold air masses that move southward from Canada over the plains states. This protection, together with the relatively low latitude of the area, results in an average of only 12 frost da/yr.

Spring is a transition period from the winter frontal activity to the dry summer. Temperatures are rising toward the summer highs, and precipitation levels are decreasing toward the low levels of the summer.

During the summer, the Pacific High is well developed to the west of California and a thermal trough overlies the California southeast desert basin. The relative humidity is very low, averaging 30 to 50% in the early morning and 10 to 20% in the late afternoon, with humidities of 10% common during the hottest part of the day. These conditions promote intense heating during the day and marked cooling at night. Temperatures of over 100°F typically occur more than 100 days each summer. The intense solar radiation that the valley receives is highly conducive to photochemical smog formation.

The fall is a transition period back to the frontal activity of the winter. Temperatures are decreasing toward the milder levels experienced in the winter. Precipitation is relatively high with an average of about 0.3 in/mo.

2.4 METEOROLOGICAL CONDITIONS

The dispersion of pollutants emitted into the atmosphere depends upon the winds and the stability of the atmosphere. Pollutant mixing in the direction of the wind is determined by wind speed. Atmospheric stability controls pollutant dispersion in the vertical and horizontal cross-wind directions. Stable conditions lead to low dispersion rates, while unstable conditions lead to high dispersion rates. The wind direction determines the locations affected by the polluted air mass.

With hourly measurements taken daily from January 1954 to December 1958 in El Centro, the National Oceanic and Atmospheric Administration (NOAA) has calculated the joint frequency distribution for the simultaneous occurrence of a particular wind speed, wind direction, and stability class.[14] The joint frequency distribution has been calculated on a seasonal and annual basis. Stability class, based on Pasquill's classification system, is a function of net solar radiation and wind speed.[15] The following discussion summarizes the NOAA results for El Centro.

The frequencies of stability classes are shown in Fig. 2.7 as bar graphs for each season. Classes A through C correspond to unstable conditions, Classes D and E to neutral conditions, and Class F to stable conditions. Stability Class F is the most common condition in the valley, especially in fall and winter.

Figure 2.8 shows the frequency distribution of wind speeds for each of the four seasons. Wind speeds are divided into 6 groups with the last group being speeds greater than 21 knots (1 knot = 1.15 mi/hr). The 0 to 3 knot group also shows the frequency of calms, f_c; a calm is defined as a wind speed less than 1 knot. The yearly average wind speed is about 7.5 knots with the strongest wind conditions occurring during the spring when the average wind speed is about 9 knots. The highest frequency of calms occurs during the winter when calm conditions occur at a frequency of about 9%. Under calm conditions pollutant transport through the valley is very slow.

During most of the year, the prevailing wind direction is predominantly from the west as shown in Fig. 2.9. While some pollutant exchange does occur between Los Angeles and Riverside Counties through the San Gorgonio pass, the Imperial Valley is essentially shielded from coastal pollutants by the high mountain ranges on the west side of the valley. During the summer, the wind has a

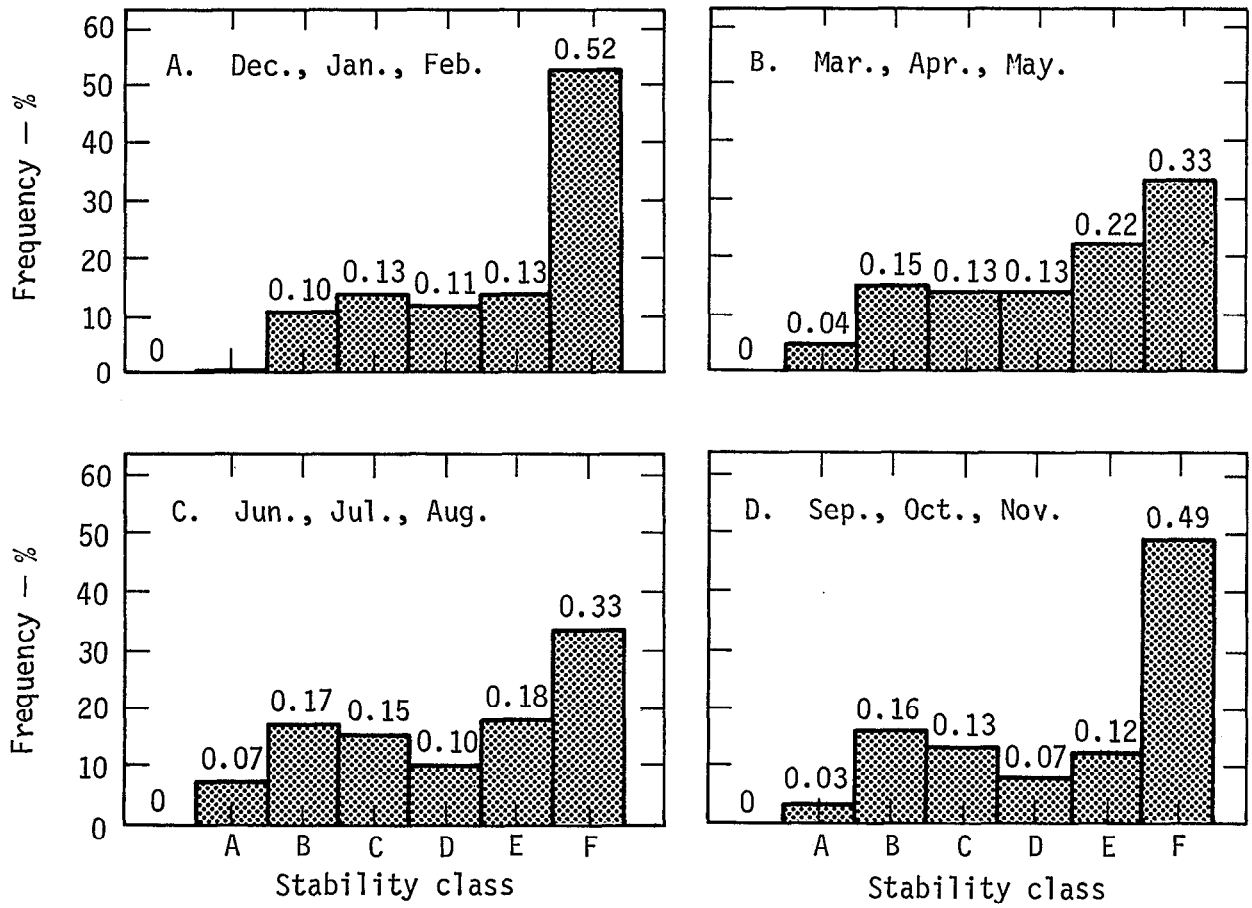

Fig. 2.7. The average atmospheric stability by class in El Centro. The classification system is that developed by Pasquill.[15] The frequency distribution is presented for each season of the year.

strong southeasterly component. Under these conditions, pollutants from the more heavily populated areas in the Mexicali Valley, Mexico, are brought into the Imperial Valley.

An additional influence on the dispersion of pollutants is the occurrence of temperature inversions. When the temperature increases with altitude, the condition is called an inversion. A rising polluted air mass that encounters a sufficiently strong inversion layer is prevented from further upward motion. Vertical mixing is then confined to the layer of air beneath the inversion. These conditions are prevalent at night throughout the year when mixing in the lower atmosphere is limited to a height of 200 to 2000 ft.[13] During the summer, inversions are destroyed early in the day by intense solar heating, but persist throughout much of the day in the winter.

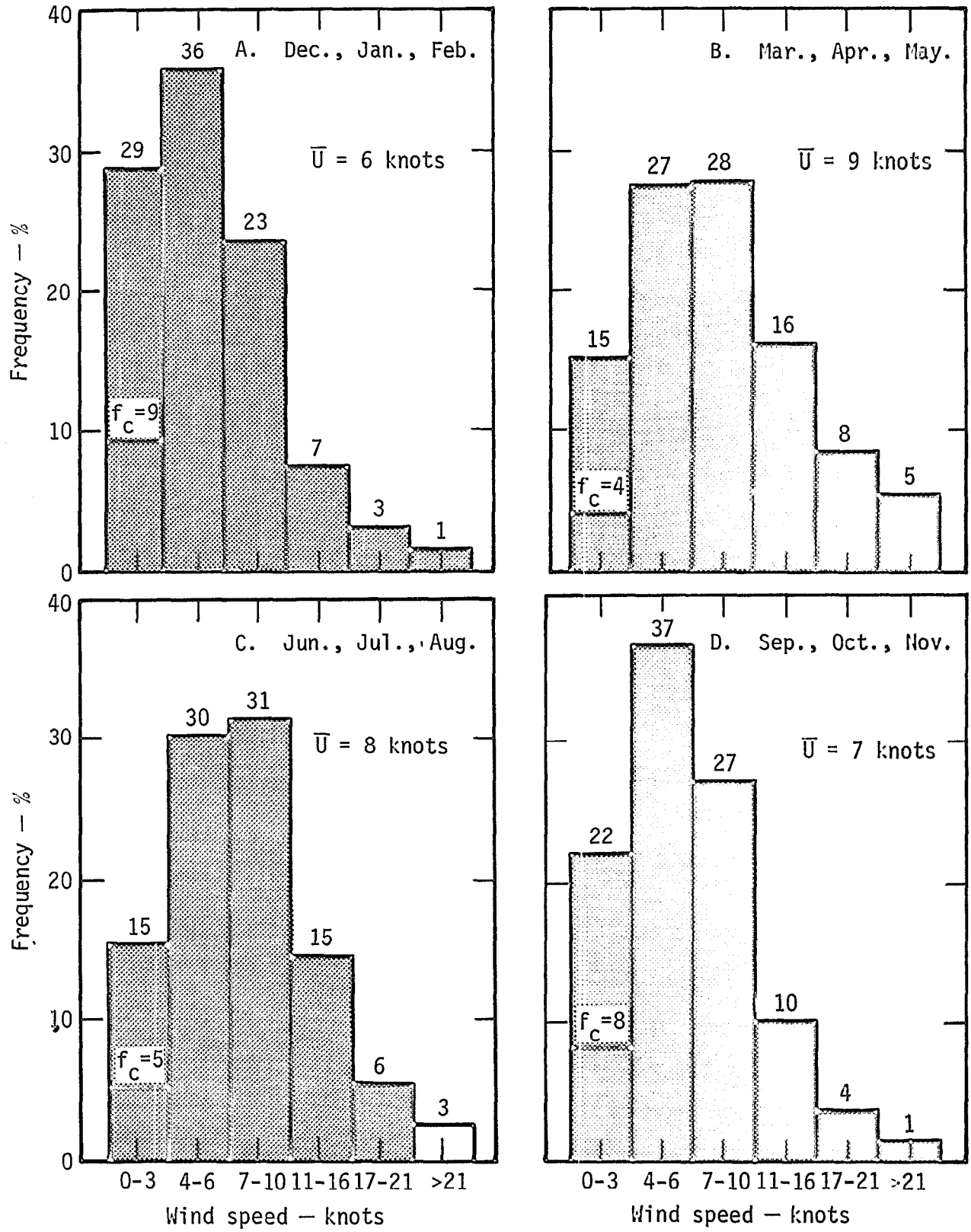

Fig. 2.8. The wind speeds at El Centro. The frequency distribution is presented for each season of the year. $\bar{U}$ = average wind speed, f_c = frequency of calms.

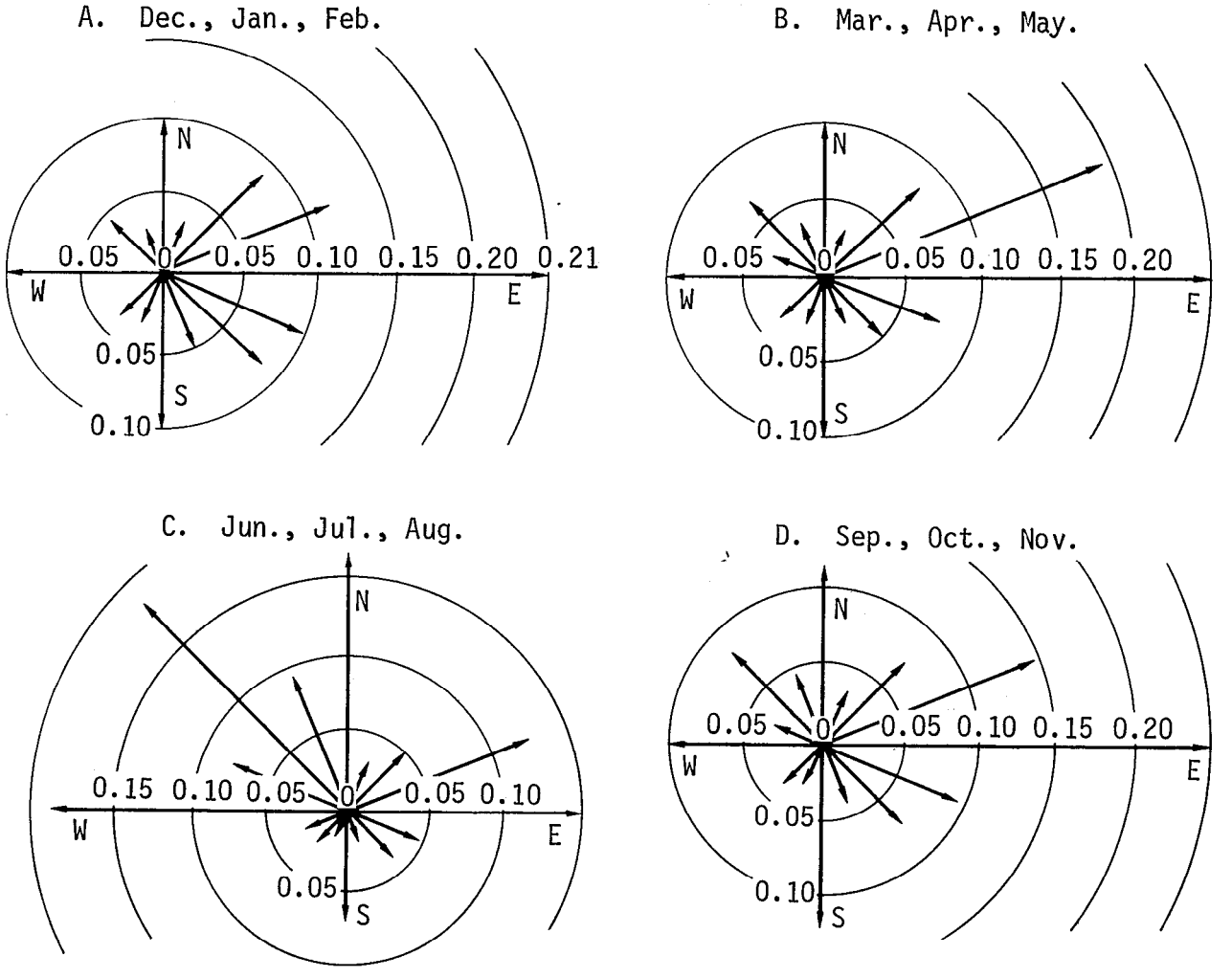

Fig. 2.9. Polar plots of the frequency distribution of wind direction at El Centro. The arrows indicate the direction from which the wind is blowing and their lengths represent the frequency of occurrence in percent.

2.5 AIR QUALITY

Stations recording air pollution concentrations are located in Brawley, Calexico, and El Centro. Sulfur dioxide (SO_2), ozone, particulates, and lead are measured at El Centro; particulates are measured at Brawley and Calexico. The nearest station measuring additional pollutants is at Indio, which is to the north of the Salton Sea. Figure 2.10 shows the monthly maximum hourly concentrations of nitric oxide (NO), nitrogen dioxide (NO_2), carbon monoxide (CO), and oxidants at the Indio station from June 1974 to May 1975. The levels of oxidant are greatest during the months of high solar radiation when the most photochemical activity occurs. Peak concentrations of CO and NO in the winter months probably reflect increased vehicular emissions associated with agricultural production and tourism. Space heating may also contribute to those concentrations.

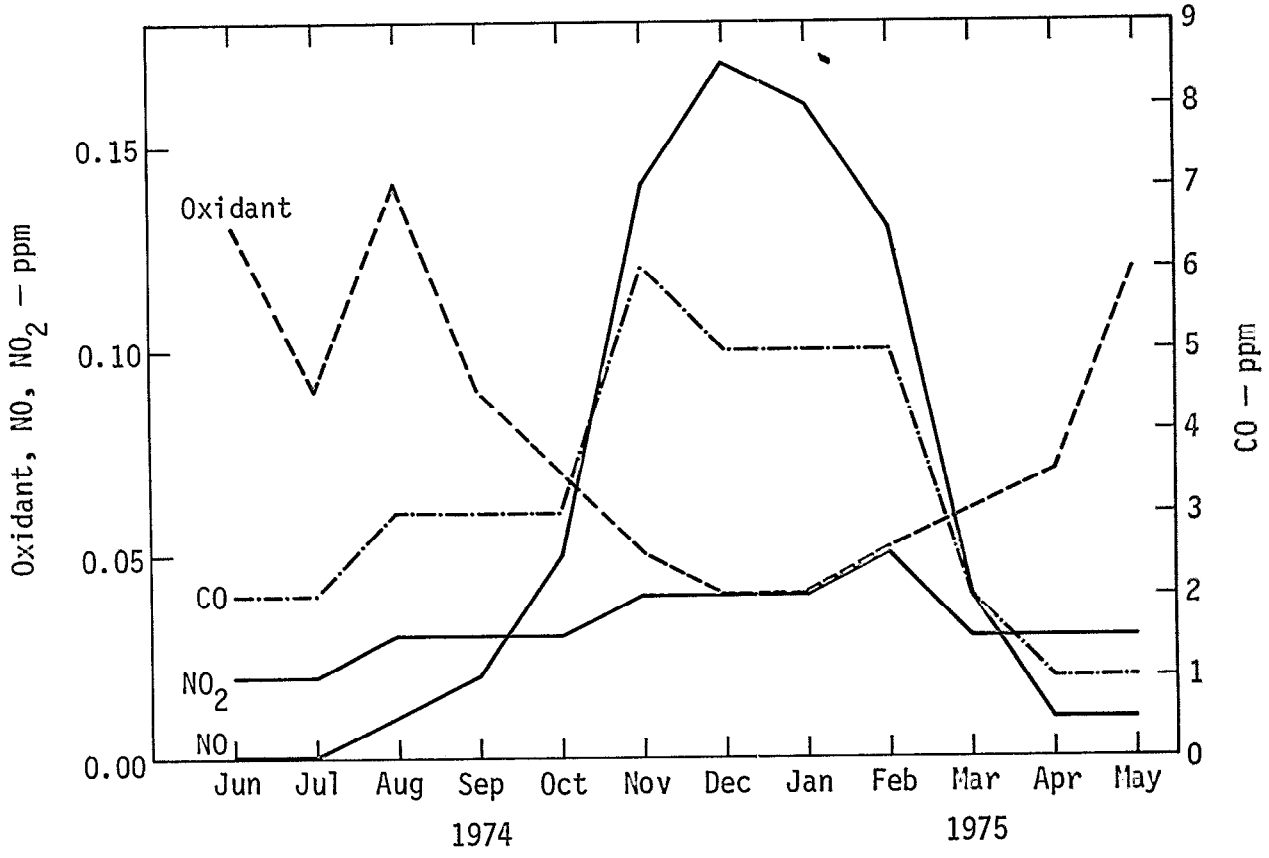

Fig. 2.10. Monthly maximum averages of oxidant, NO, NO_2, and CO at Indio, California.[16]

Air pollutants monitored in the Imperial Valley exhibit seasonal patterns similar to those at Indio. For example, the monthly maximum hourly averages of ozone, a photochemical oxidant, decrease in the winter at El Centro (Fig. 2.11) as do the oxidant levels measured at Indio. Atmospheric lead, which is derived mainly from motor vehicles, rises in the winter months (Fig. 2.12) when there is more traffic in the valley. The same increase is seen in NO and CO levels at Indio.

Monthly maximum hourly averages of SO_2 (Fig. 2.11) remain almost constant throughout the year. The absence of major industrial sources of SO_2 accounts for its static nature. Particulate concentrations, in contrast, display a lot of variability. Monthly mean particulate concentrations at El Centro and Calexico (Fig. 2.13) reveal temporal differences that are probably related to the type of ground cover in the vicinity of the cities as well as to localized meteorological conditions. The relatively high level of particulate mass loading at these stations seems to represent a regional phenomenon since Brawley, located

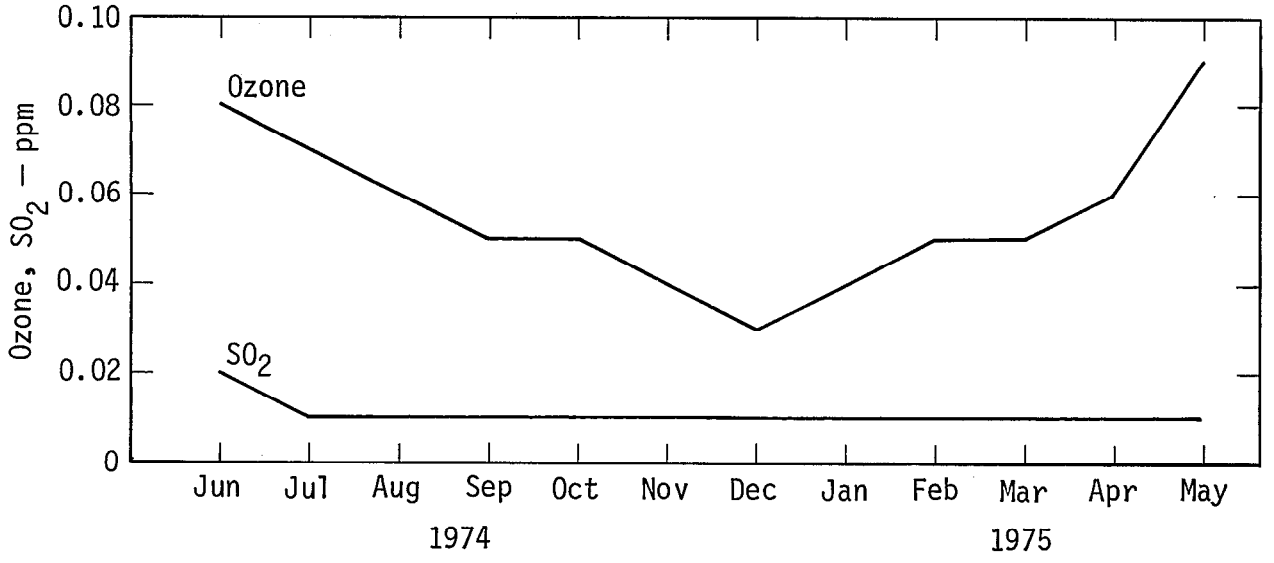

Fig. 2.11. Monthly maximum hourly averages of ozone and SO_2 at El Centro, California.[16]

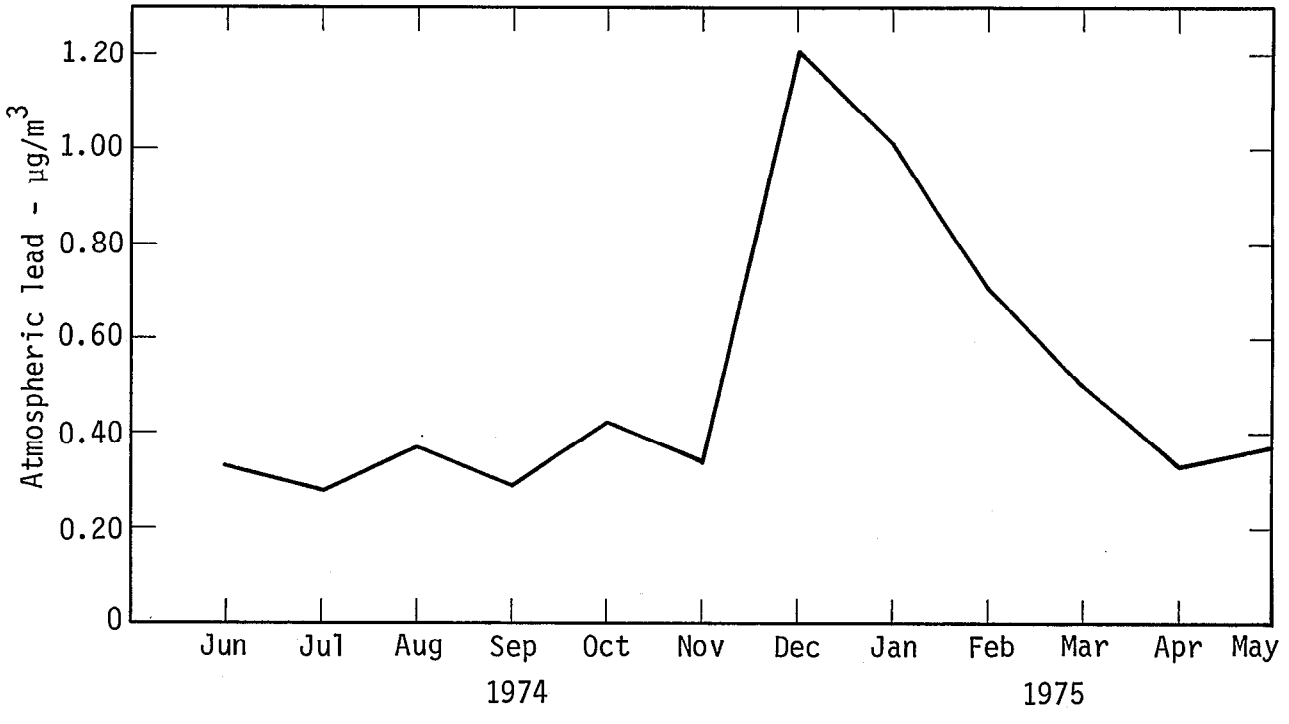

Fig. 2.12. Monthly averages of atmospheric lead at El Centro, California.[16]

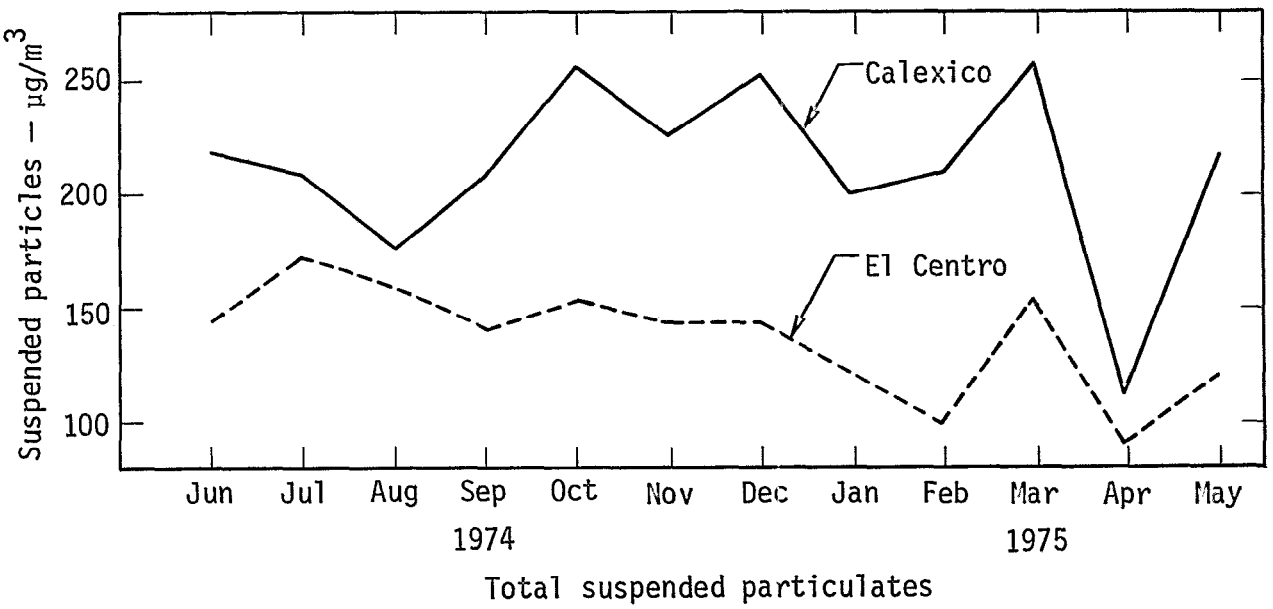

Fig. 2.13. Total suspended particulates. Mean of 24-hr observations.[16]

near the middle of the valley, also records high particulate levels. In fact, during a 12-month period (June 1974 to May 1975) the geometric mean of particle concentrations measured at the Brawley stations was 211 $\mu g/m^3$, higher than both the annual primary and secondary national standards (i.e., 75 $\mu g/m^3$ and 60 $\mu g/m^3$).

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Section 3
Water Resources

David Layton

About 3 million acre-feet (af) of Colorado River water are diverted to the Imperial Valley each year to support irrigated agriculture. Over 1,700 miles of main canals and laterals distribute water to a service area encompassing 501,264 acres of which about 475,000 acres are irrigated. Another 1,400 miles of drainage ditches carry waste waters to the Salton Sea. Underlying the valley are shallow aquifers exhibiting both artesian and water table conditions. The deeper aquifers contain large amounts of water, some of which is geothermally heated to temperatures greater than 300°C. Surface waters range from about 900 ppm total dissolved solids (TDS) below Drop 1 on the All American Canal (see Fig. 3.1) to over 39,000 ppm in the Salton Sea; ground water salinities range from a few hundred ppm in East Mesa to over 10,000 ppm in scattered wells situated in the middle of the valley.

3.1 GROUND WATER

Information on the hydrologic properties of the valley's water-bearing sediments is largely restricted to shallow aquifers where pump tests have been conducted. Those tests show that the most productive aquifers are found on the east and west sides of the valley. Transmissivities computed from pump tests vary from 37,000 to about 300,000 gal/da-ft on the western side of the valley; 47,000 to over 800,000 gal/da-ft in the East Mesa — Sand Hills area. The probable range of transmissivities for the central valley is from 1,000 to 10,000 gal/da-ft at depths to 500 ft. Transmissivities are greatest on the eastern and western sides of the valley because the alluvial deposits in those areas have higher permeabilities than the finer grained silts and clays of the valley floor.

The main source of recharge to aquifers is the unlined canals that distribute irrigation water to the Coachella and Imperial Valleys. From 1950 to 1967 the calculated cumulative leakage along the All American Canal from Pilot Knob to the East Highline Canal was approximately 4.5 million af.[1] Leakage during the same period along the Coachella Canal (from the All American Canal to a point parallel with Niland) was estimated to be 2.7 million af. In comparison to this artificial recharge, natural recharge to the valley from the Colorado River is estimated at just 17,000 af

annually.[1,2] Some recharge is also associated with deep percolation of irrigation water; however, an extensive subsurface drainage system removes most of that water to the Salton Sea.

Water is discharged from the shallow aquifers to springs, wells, rivers, agricultural drains, and the Salton Sea. Springs yield a few thousand acre-feet each year as do flowing wells in an area between the East Highline Canal and the Alamo River. Annual discharge from the alluvial aquifers bordering the southern portion of the Salton Sea is probably more than 10,000 af.[3] An additional 10,000 to 20,000 af discharges to rivers and drains.[1]

The movement of ground water in the valley is shown by the water-level contour map in Fig. 3.1. Recharge areas are located near San Felipe Creek, East Mesa, Niland, and West Mesa. Ground water discharge occurs along the lower reaches of the New and Alamo Rivers, as indicated by the bending of the contours upstream as they cross the rivers.

The amount of water held in storage by the valley's aquifers is enormous. Dutcher et al.[2] estimate that 1.1 billion af of recoverable water is contained in water bearing sediments, and their estimate does not even include geothermal brines having salinities in excess of 35,000 ppm TDS. Nearly a third of the recoverable water (349 million af) resides in a vertical zone defined by Dutcher et al.[2] as extending from the water table to a surface limited by either bedrock, the 100°C isotherm, or a depth of 3,000 feet, whichever is shallowest. Aquifers underlying the Sand Hills, East Mesa, and West Mesa portions of the valley that are in this zone have specific yields (i.e., the volume of water a saturated sediment will yield to gravity divided by the sediment's total volume, expressed as a percent) ranging from 15 to 20%.

3.2 GROUND WATER QUALITY

In general, the ground water quality of the shallow aquifers is best on the eastern and western sides of the valley. Water of lesser quality is found in both the central and western parts of the valley. According to U.S. Geological Survey Professional Paper 486-K,[1] which has water quality data from the late 1950's and early 1960's, wells on East mesa yielded water with TDS's ranging from over 500 ppm to 7,280 ppm TDS. Most of those wells, however, had water less than 1,000 ppm TDS. Ground waters in the central valley, on the other hand, were almost all between 1,000 ppm to 3,000 ppm TDS. The highest TDS in a well was 15,700 ppm. In the western section of the valley, water varied

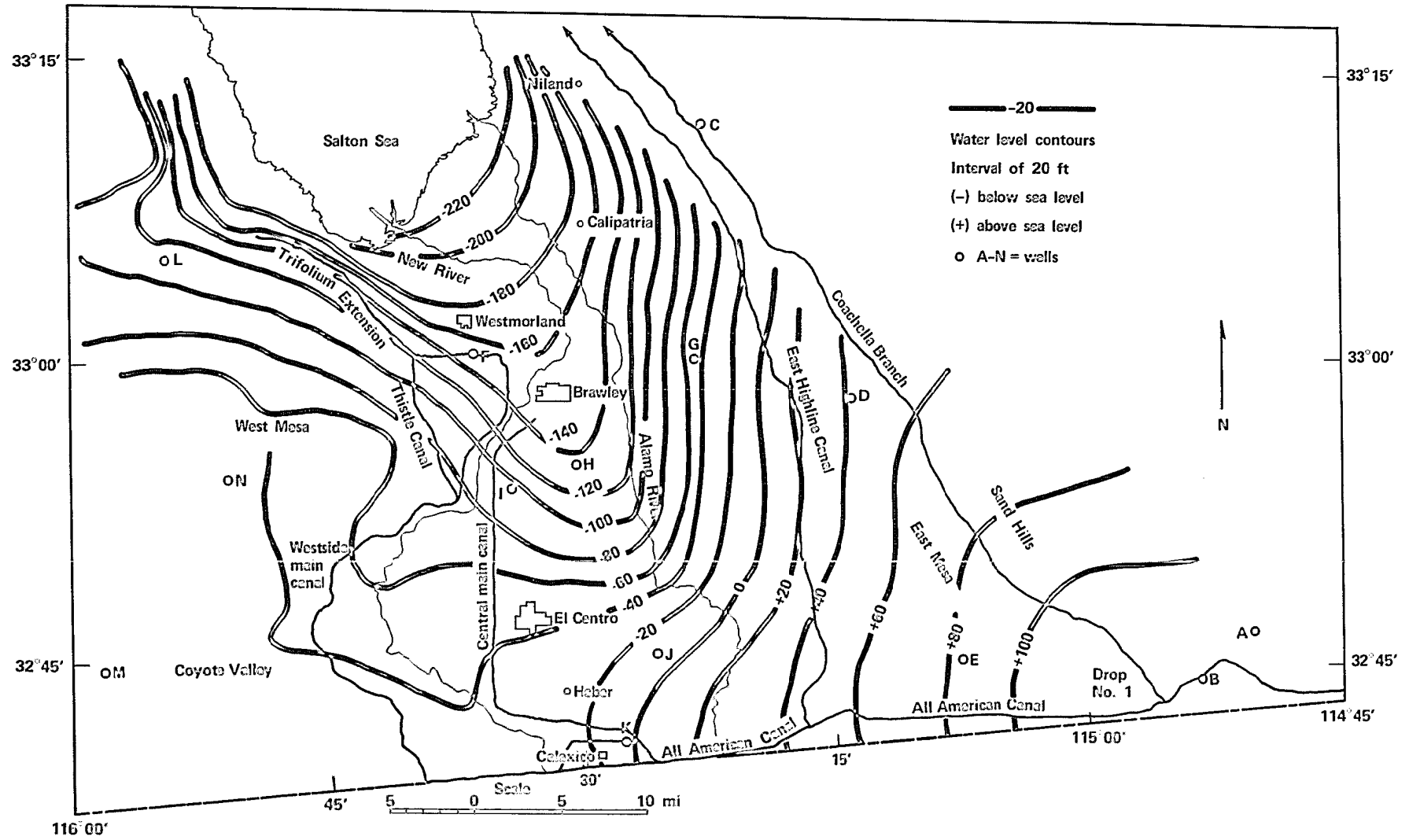

Fig. 3.1. Water-level altitudes in 1965 for Imperial Valley.[1]

widely in quality: almost all of Coyote Valley's wells (see Fig. 3.1) had water below 500 ppm, while West Mesa wells had water between 1,800 ppm and 5,200 ppm. Table 3.1 gives chemical analyses of selected wells in the Imperial Valley.

3.3 SURFACE WATER

Surface waters in the valley are derived from the Colorado River at Imperial Dam. Water imported by the Coachella Valley County Water District (CVCWD) and the Imperial Irrigation District (IID) is part of California's share of the Colorado River. In addition, Mexicali Valley receives water from the Colorado River, some of which drains across the border in the New and Alamo Rivers. Because of soil salinity problems, an extensive subsurface drainage system has evolved since 1929 that removes salts leached through soils underlying more than 388,000 acres. Drain water resulting from leaching as well as direct runoff from irrigated fields is carried by drainage structures to the New River, Alamo River, and the Salton Sea.

Imported Colorado River water or drainage waters are possible sources of cooling water for geothermal power plants. The availability of those waters for cooling — irrespective of institutional and legal considerations — is presently dependent on irrigation practices and cropping trends. Historic flows into the valley measured at Drop No. 1 on the All American Canal have averaged below 3 million af since 1951 (Fig. 3.2); the corresponding waste water flows to the Salton Sea average between 35 and 40% of the in-flows at Drop No. 1.

Daily diversions to Imperial Valley from the Imperial Dam are based on requests submitted to the U.S. Bureau of Reclamation by the IID. Those requests are made one week in advance of the actual diversions and are based on the anticipated water use in the valley. The demands for water follow planting and harvesting schedules, peaking in the months of April, July, August, and September when crops are planted.[4,5] Water destined for the valley is released at Parker Dam, flows 3 days to reach the Imperial diversion dam, then takes another day in transit to the Imperial Valley.[6]

When the water arrives in the canals of the irrigation district, its distribution is governed by water orders submitted to the IID by the valley's irrigators 3 days prior to delivery.[7] The ability of the irrigation system to meet water requests for a given day depends on the amount of water already stored in the district's canals plus the inflow from the All American Canal. Other than the storage capacity of the canals, which is being reduced

Table 3.1. Water quality data for selected wells in the Imperial Valley.[1]

Well identification[a]	Interval sampled (ft below land surface)	Year (19)	Silica (SiO_2)	Calcium (Ca)	Magnesium (Mg)	Sodium and potassium	Bicarbonate (HCO_3)	Sulfate (SO_4)	Chloride (Cl)	Fluoride (F)	Total dissolved solids	Hardness as $CaCO_3$		Percent sodium	pH
												Calcium magnesium	Non-carbonate		
						(in mg/l.)									
A	150-152	62	4	40	10	301	116	135	397	--	945	142	47	82	6.9
B	127-144	63	15	95	32	126	174	317	119	.3	791	368	226	43	7.5
C	25-150	63	33	106	107	503	212	700	635	1.6	2,190	705	531	61	7.4
D	113-115	62	27	88	45	578	147	308	865	--	1,980	405	284	76	8.1
E	155-157	64	22	26	11	280	150	212	265	1.4	892	112	0	84	8.0
F	145-147	62	16	564	460	3,100	434	1,250	5,950	--	11,600	3,300	2,940	67	7.2
G	---	62	18	31	8.6	952	424	525	915	--	2,660	113	0	95	8.1
H	82-84	62	16	1,610	1,110	1,770	352	2,050	7,100	--	13,800	8,580	8,290	31	7.2
I	124-126	62	25	676	417	3,930	416	875	7,580	--	13,700	3,400	3,406	72	7.4
J	145-147	62	14	376	214	2,920	267	400	5,350	--	9,410	1,820	1,600	78	7.4
K	150-152	62	11	244	161	1,530	257	850	2,490	--	5,410	1,270	1,060	72	--
L	---	62	0	109	46	1,590	66	5	2,740	--	4,520	462	408	88	6.6
M	---	62	20	25	7.4	108	156	43	109	1.0	391	93	0	72	7.9
N	135-560	62	15	152	33	510	64	1,080	318	--	2,140	515	463	68	7.7

[a] See Figure 3.1 for location.

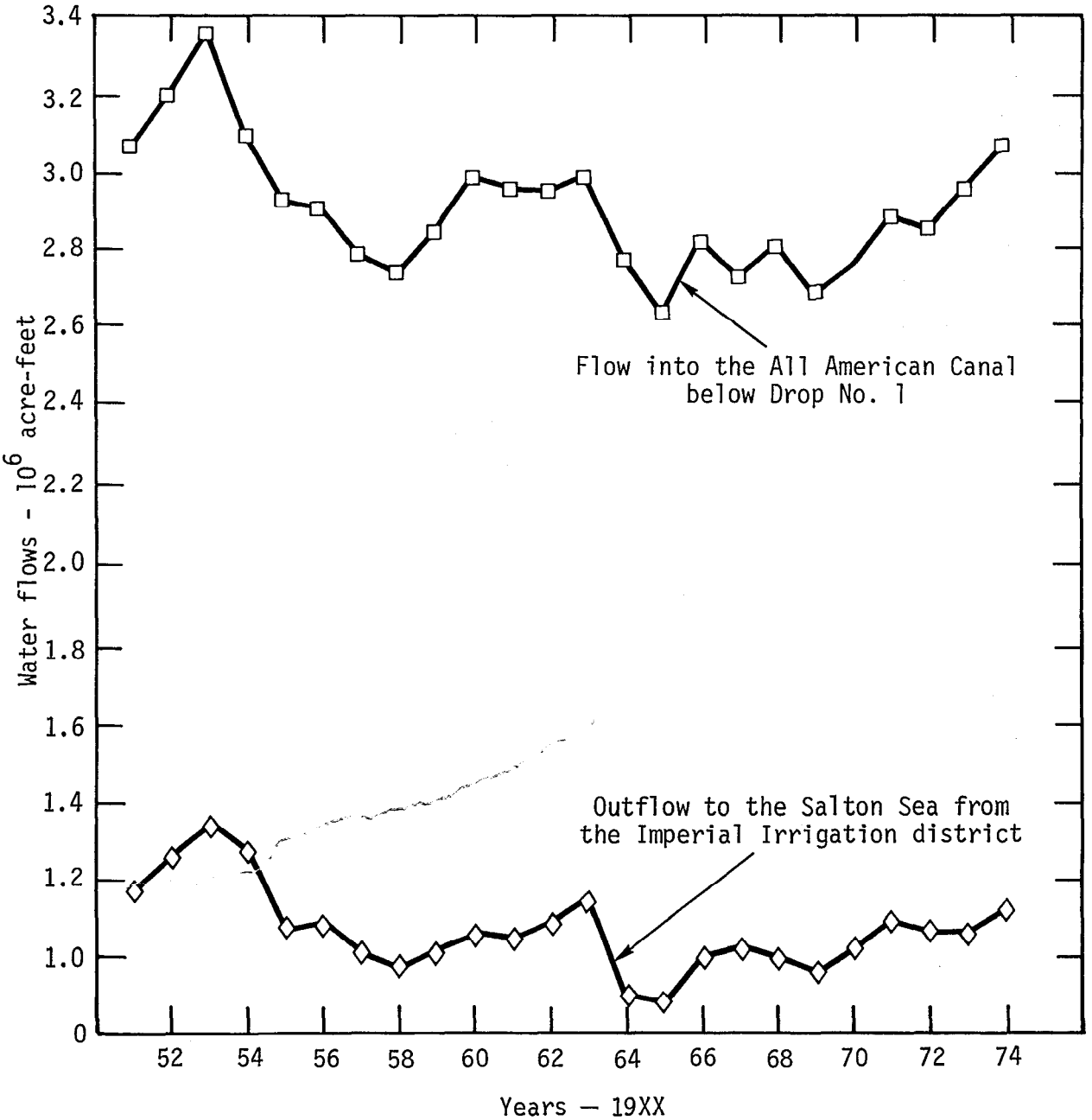

Fig. 3.2. Inflows and outflows of the Imperial Irrigation District during 1951-1974.[5]

by concrete lining, there is only one regulatory pond within the irrigation system to provide hold-over storage for periods when a surplus of water occurs.

The Senator Wash facility on the Colorado River can also be used for temporary storage by IID during times of excess water in the canals.

3.4 SURFACE WATER QUALITY

The quality of surface water in the valley depends primarily upon the chemical, physical, and biological characteristics of Colorado River water; New River inflows from Mexico; and effluent flows from the irrigation system. Of particular concern within recent years has been the deteriorating quality of Colorado River water diverted to the valley. Figure 3.3 shows a distinct rising trend in the river's salinity, which now stands at about 850 ppm TDS. Predictions of salinity[8,9] indicate continued increases that, even with salinity

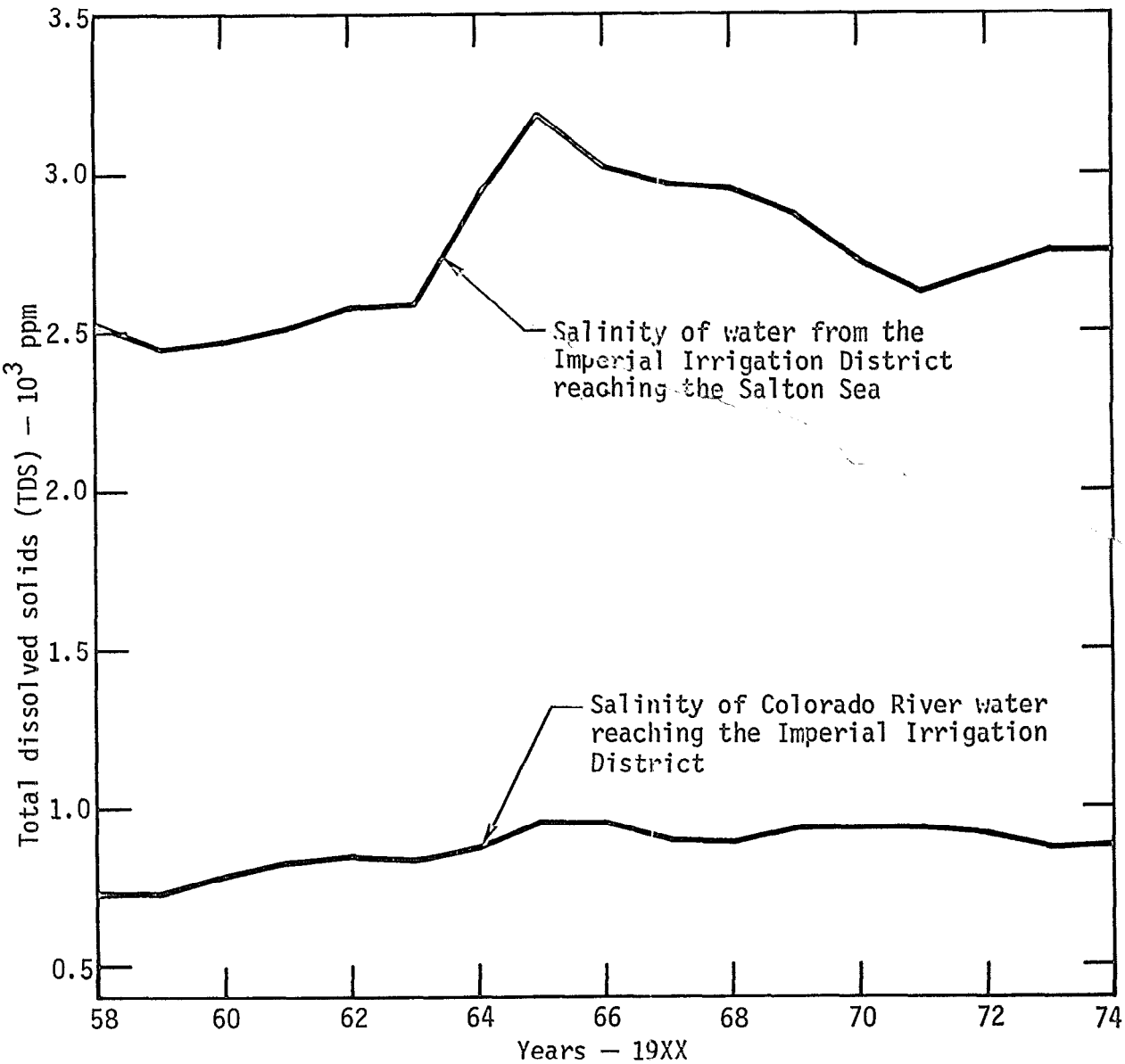

Fig. 3.3. Salinities of water entering and leaving the Imperial Irrigation District (excludes water and salt from Mexico).[5]

control measures, may exceed 1,000 ppm TDS by 1990. And as salinity increases, crop yields should decrease unless corrective steps are taken.[10] Another problem area has been the release of untreated sewage into the New River on the Mexican side of the border. This problem should be resolved when a new sewage treatment plant is completed by the Mexican government.

Effluent flows from agricultural lands affect water quality adversely by increasing the mineral burden of the New and Alamo Rivers and by contributing other pollutants (e.g., pesticides and nutrients) to the runoff that eventually ends up in the rivers. Because of the salt problem in the valley, water analyses have focused on the dissolved ionic constituents of the inflowing and outflowing waters to obtain a salt-balance for the valley. In recent years those analyses have shown that more salt has been removed from the valley than has been brought in, resulting in a positive balance. In 1974 the salt balance of waters in the irrigation district[5] showed that 534,326 more tons of salt were discharged from the district than were brought in. The excess salt is derived principally from leaching of soils plus contributions from saline ground water.[4]

Alterations in the dissolved constituents present in water moving through the irrigation system are given in Fig. 3.4. According to Kaddah and Rhoades,[4] the smaller relative amounts of HCO_3^-, $SO_4^=$, and Ca^{++} in the drainage waters are probably caused by the precipitation of $CaCO_3$ and CaSO. A bar graph of the ionic composition of Salton Sea water indicates a relatively minor amount of HCO_3^-; the dominant ions are Na^+ and Cl^-.

3.5 SALTON SEA

The initial filling of the Salton Sea occurred in the years 1904 to 1907 when control works on the Colorado River, meant to regulate diversions of river water to the Imperial Valley, failed and allowed most of the river to flow into what was called the Salton Sink.[3] Since then the sea has been sustained by agricultural drainage waters and its primary beneficial use is the storage of agricultural waste waters. Its status as a depository for waste waters was guaranteed when, in 1924, President Coolidge withdrew all public lands in the Salton Sea area that were below an elevation of 244 ft, establishing a public water reserve.[12] In 1928 the President extended the reserve by withdrawing all public lands below an elevation of 220 ft.

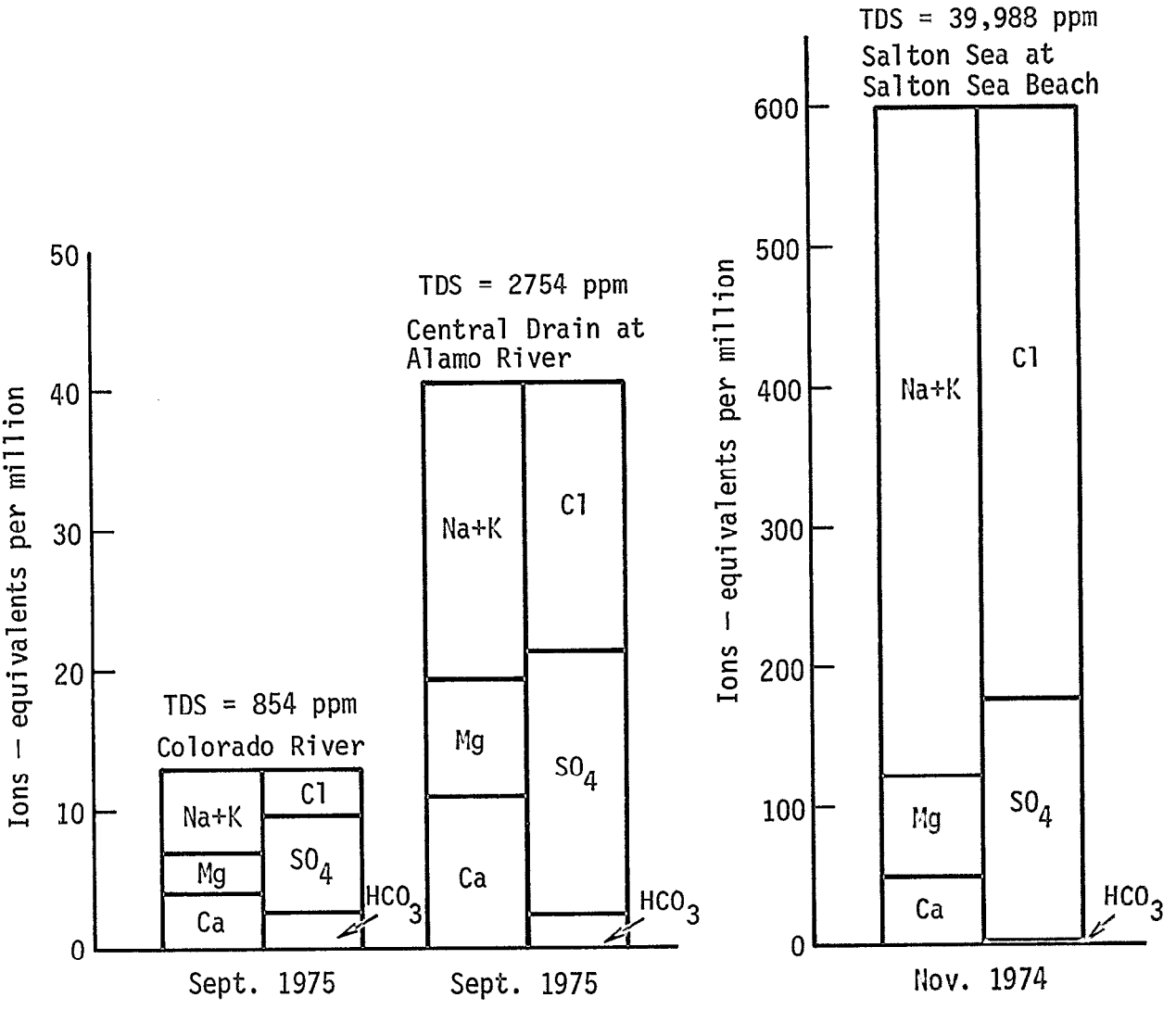

Fig. 3.4. Constituents of Colorado River water, Central Drain water, and Salton Sea water.[5,11]

Inflows to the sea have been partially balanced by evaporation that has averaged over 1,200,000 af per year.[3] Whenever the evaporation does not keep pace with inflows from the Coachella and Imperial Valleys, the level of the sea rises. The historic relationship between surface elevation and area are depicted in Fig. 3.5. Continued rising of the sea has caused flooding and drainage problems along its southern edge. This situation is likely to continue until irrigation and cropping practices are altered.

Directly related to the amount of inflows and evaporation is the change in the sea's salinity, which has risen to over 39,000 ppm TDS (see Fig. 3.6). The sea's salinity can be expected to increase gradually because of salt loading from brackish irrigation waste waters and volumetric reductions due to evaporation.

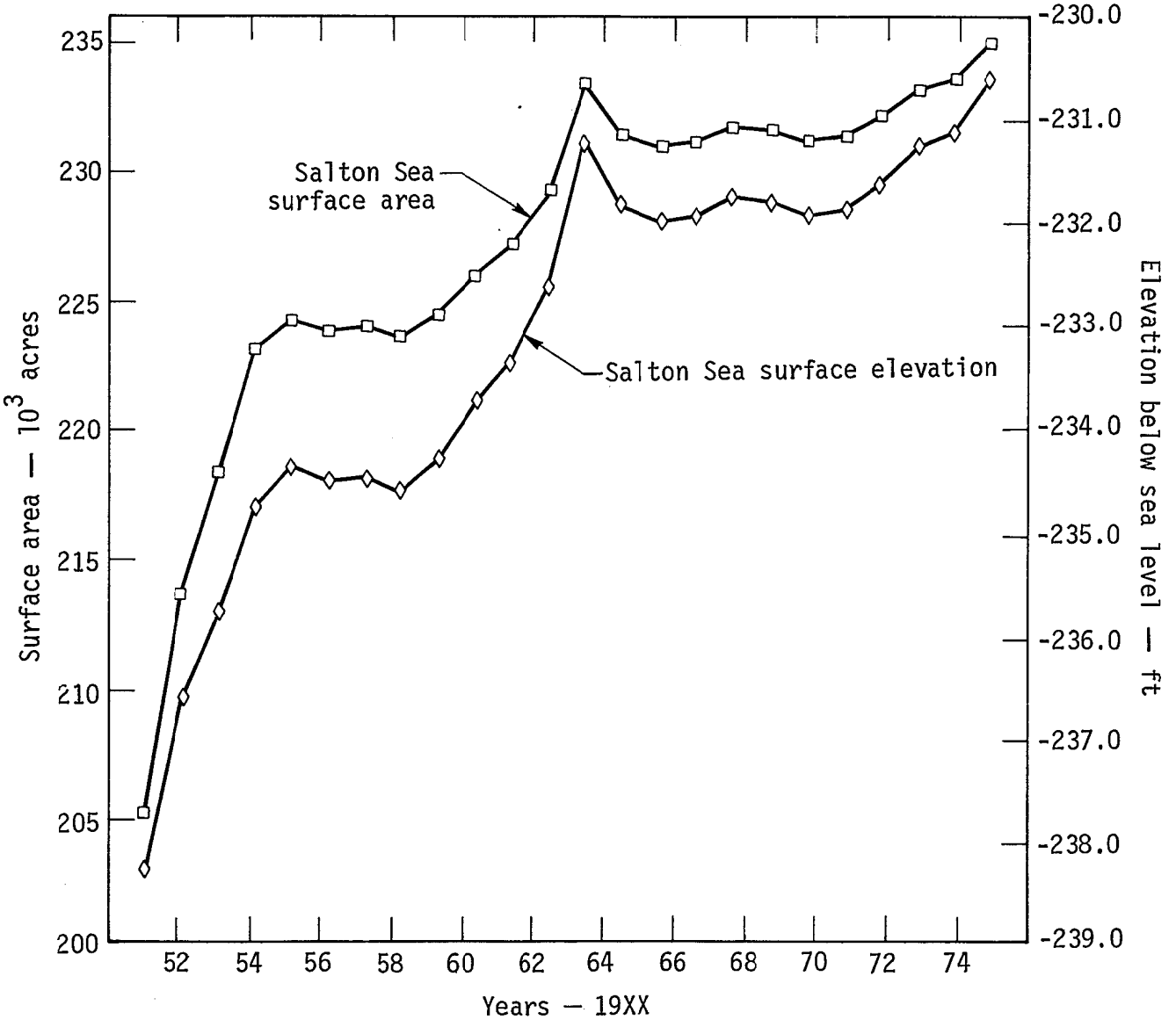

Fig. 3.5. Surface area and elevation of the Salton Sea during 1951-1974.

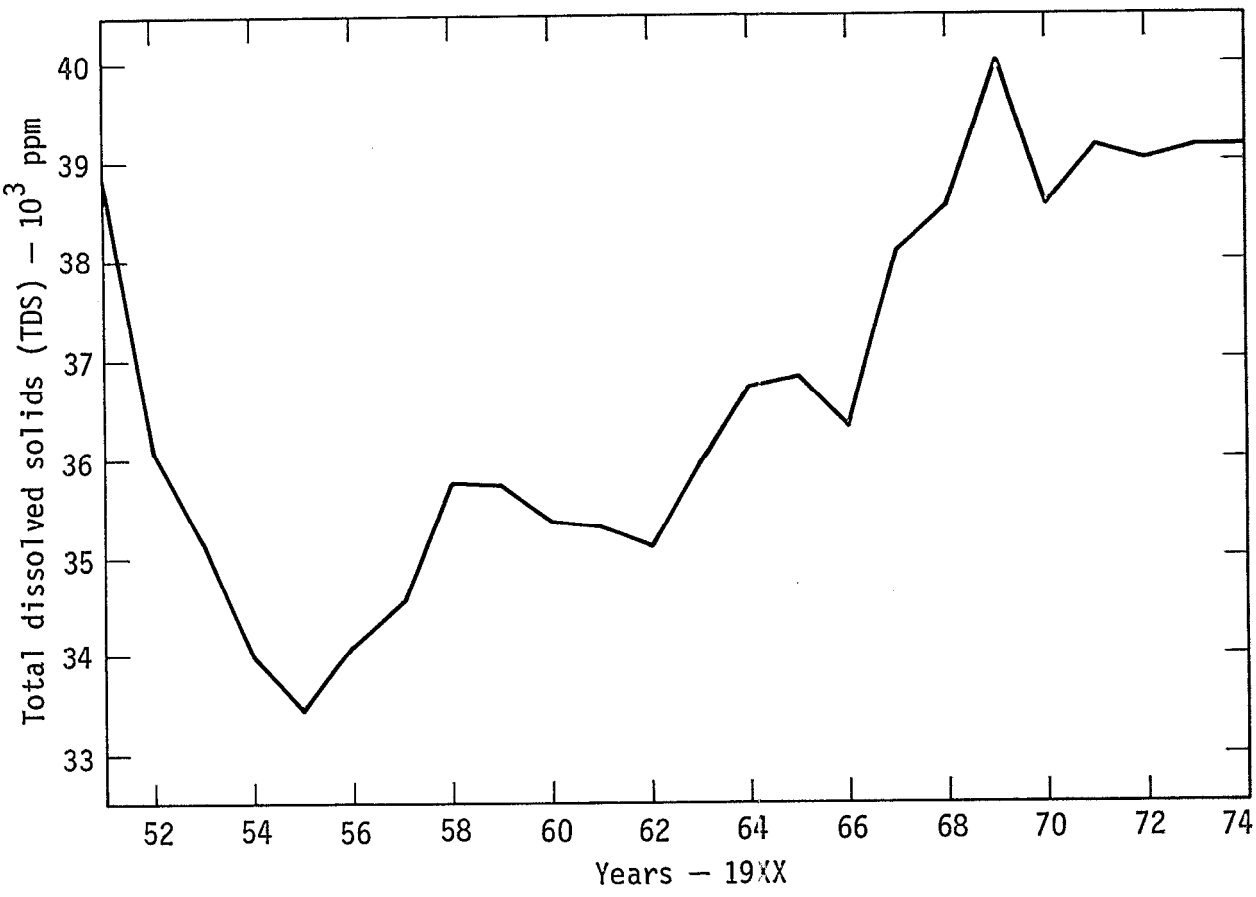

Fig. 3.6. Historic salinity of the Salton Sea. Salinity values are the average of samples taken from Bertram Station, Desert Beach, Sandy Beach, and Salton Sea Beach.[5]

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Section 4
Biological Resources

J. R. Kercher and Mary Buchanan

In the absence of man, the vegetation of the Imperial Valley would be creosote bush-bur sage desert communities. However, because of man's activities, there is a large irrigated agricultural district and a large inland salt water sea. Four ecological systems in the Imperial Valley will be considered in this chapter: agricultural, the Salton Sea quasi-marine ecosystem, wildlife refuges and endangered species, and native desert communities.

4.1 AGRICULTURE

The unique climate of the Imperial Valley makes it one of the most valuable agricultural resources in the nation. In 1974, there were 489,000 acres in agricultural production that generated a gross sales of $557 million. Of this $557 million, livestock and dairy accounted for $155 million, field crops $284 million, and vegetable crops $103 million.[1] These 489,000 acres are divided into more than 8000 parcels.[2] It is the largest single area of irrigated agriculture in the Western Hemisphere.[3] The climate of the Imperial Valley is hot and dry with an average annual rainfall of 2.7 inches[4] and a maximum temperature over 100°F for more than 110 days of the year.[3] There is an average of 314 days between frosts and 12 days of frosts.[4] The annual average relative humidity is below 30% with the summer months of July, August, and September the highest. This is because the prevailing winds in the summer come from the south (Gulf of California); during the rest of the year the prevailing winds are from the west.[4]

Probably the single most important problem for agriculture in the Imperial Valley is soil salinity.[5] The irrigation system is intimately tied to this problem. The water management aspects of the Imperial Valley are discussed in detail elsewhere. In this section the soil salinity problem is addressed explicitly.

The agricultural area under irrigation is shown in Fig. 4.1.

Crops

The crops grown in the valley during the years 1973 through 1975 are listed in Table 4-1.[6] Table 4-2 describes the total area served by irrigation. In terms of acreage the most important crops are alfalfa,

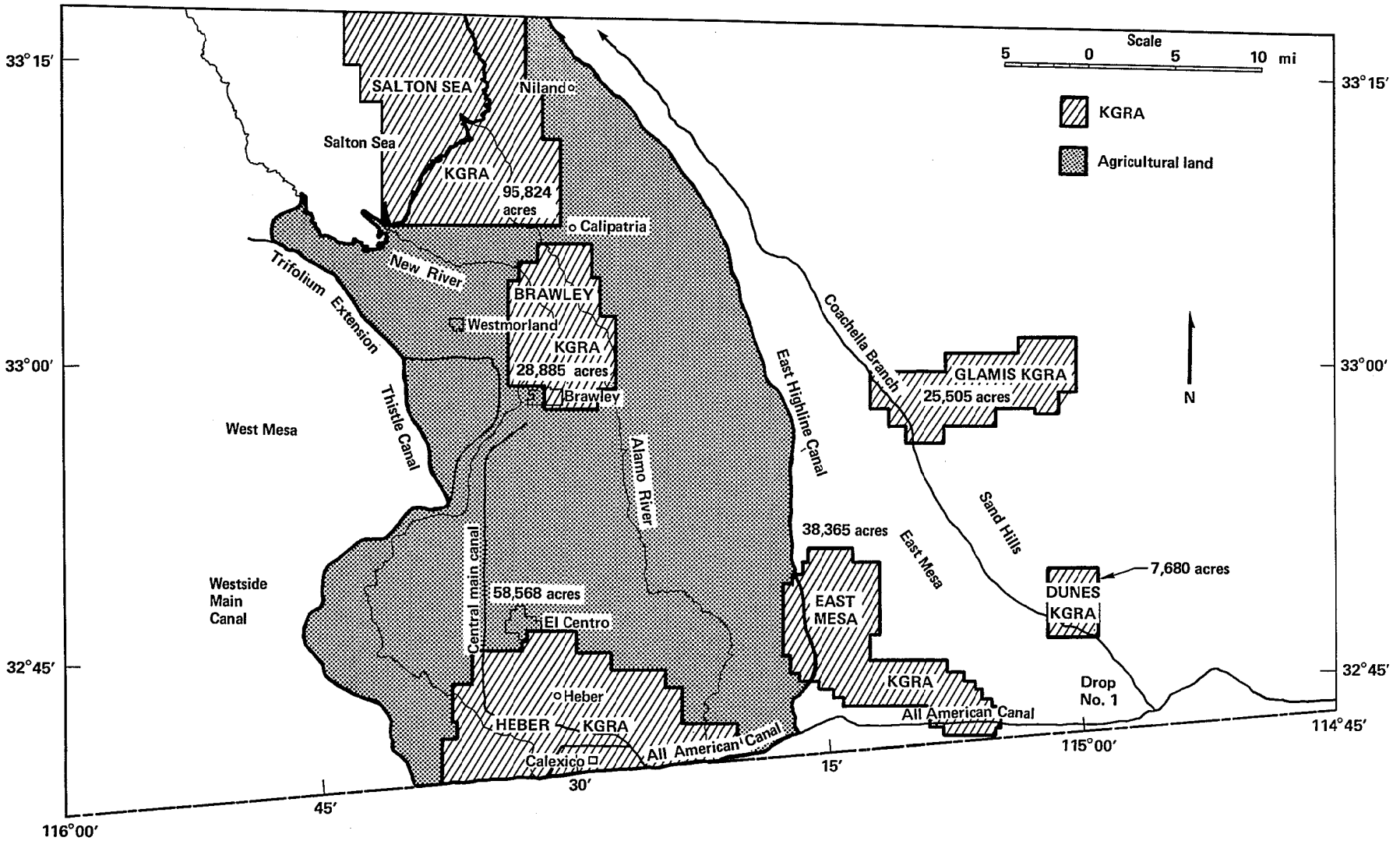


Fig. 4.1. Map of Imperial Valley. The six KGRAs are outlined on this map. Irrigated, agricultural lands are shown as the shaded areas.

Table 4.1. Crop acreage[a] in the Imperial Irrigation District.[6]

Garden crops	Acres		
	1975	1974	1973
Broccoli	773	710	239
Broccoli (seed)	17	11	17
Cabbage	319	1 429	626
Carrots	5 988	6 385	5 040
Carrots (seed)	22	49	27
Cauliflower	5	--	64
Cauliflower (seed)	45	73	42
Collards (seed)	33	41	--
Cucumbers	981	503	233
Ear Corn	4	--	467
Endive	20	7	--
Endive (seed)	22	--	--
Garlic	1 395	708	678
Herbs, mixed	40	28	6
Lettuce	44 912	48 376	40 701
Lettuce (seed)	118	--	--
Lettuce, Romaine	113	34	167
Melons			
Cantaloupes	7 559	8 888	9 570
Cantaloupes (seed)	45	10	--
Crenshaw	363	143	293
Honeydew	842	148	369
Mixed	60	4	75
Watermelons	2 472	1 573	2 659
Watermelons (seed)	--	28	--
Mustard	310	225	339
Okra	23	46	20
Okra (seed)	45	6	--
Onions	7 509	6 273	4 462
Onions (seed)	1 248	1 469	858
Parsley (seed)	20	--	--
Parsnips	30	45	--
Peas	223	40	--
Peas (seed)	136	--	--
Rapini	259	280	136
Rutabagas	45	20	--
Squash	1 287	970	1 241
Squash (seed)	--	17	--
Tomatoes	5 736	2 909	2 257
Tomatoes (seed)	132	--	--
Turnips	62	53	--
Vegetables, mixed	212	122	199
Vegetables, mixed (seed)	35	18	29
Waterlilies	16	25	20
Totals	83 476	81 666	70 834

Table 4.1. (Continued)

Field crops	Acres 1975	1974	1973
Alfalfa	158 784	155 608	174 567
Alfalfa (seed)	627	2 383	1 660
Alicia grass	2 900	2 797	2 722
Barley	3 481	5 358	17 433
Bermuda grass	2 158	2 403	1 968
Bermuda grass (seed)	1 046	964	964
Cotton	43 000	78 808	36 857
Flax	145	40	80
Oats	275	1 002	1 245
Rape	--	46	--
Rye grass	8 766	8 875	17 456
Rye grass (seed)	203	294	509
Safflower	170	--	16
Sesbania	221	--	--
Sesbania (seed)	--	--	79
Sorghum grain	24 271	31 610	39 389
Sorghum silage	560	417	1 032
Soy beans	--	--	2
Sudan grass	13 047	14 450	13 224
Sugar beets	71 425	69 108	69 812
Wheat	155 575	101 499	94 407
Totals	486 654	475 662	473 422
Permanent crops			
Apricots	22	22	22
Asparagus	4 426	5 066	5 034
Citrus			
Grapefruit	600	657	618
Lemons	968	967	836
Mixed	292	285	380
Oranges	409	444	444
Tangerines	256	268	282
Dates	76	76	83
Duck ponds (feed)	6 809	7 020	7 348
Fish farms	425	465	426
Fruit, mixed	100	73	73
Ornamental shrubs	8	8	8
Pasture, permanent	997	556	749
Peaches	35	35	35
Pecans	47	47	47
Totals	15 470	15 989	16 385
Total acres of crops	585 600	573 317	560 641

[a]Crops are listed for the year in which they are predominantly harvested.

Table 4.2. Summary of area served by Imperial Irrigation District.[6]

	Acres		
	1975	1974	1973
Field crops	486 654	475 662	473 422
Garden crops	83 476	81 666	70 834
Permanent crops	15 470	15 989	16 385
Total acres of crops	585 600	573 317	560 641
Total duplicate crops	129 466	123 555	117 025
Total net acres in crops	456 134	449 762	443 616
Area being reclaimed: leached	581	676	973
Net area irrigated	456 715	450 438	444 589
Area farmable but not farmed during year (fallow land)	20 146	25 522	29 146
Total area farmable	476 861	475 960	473 735
Area of farms in homes, feed lots, corrals, cotton gins, experimental farms, and industrial areas	13 300	13 279	13 498
Areas in cities, towns, airports, cemeteries, fairgrounds, golf courses, recreational parks and lakes, and rural schools, Less area being farmed	12 239	12 025	12 693
Total area receiving water	502 400	501 264	499 926
Area in drains, canals, rivers, railroads, and roads	71 515	71 577	71 357
Area below -230 Salton Sea Reserve boundary and area covered by Salton Sea, less area receiving water	36 628	36 628	36 628
Area in Imperial Unit not entitled to water	63 933	63 933	63 933
Undeveloped area of Imperial, West Mesa, East Mesa, and Pilot Knob units	300 597	301 671	303 229
Total acreage included - all units	975 073	975 073	975 073
Acreage not included - all units	87 217	87 217	87 217
Total gross acreage within district boundaries	1 062 290	1 062 290	1 062 290

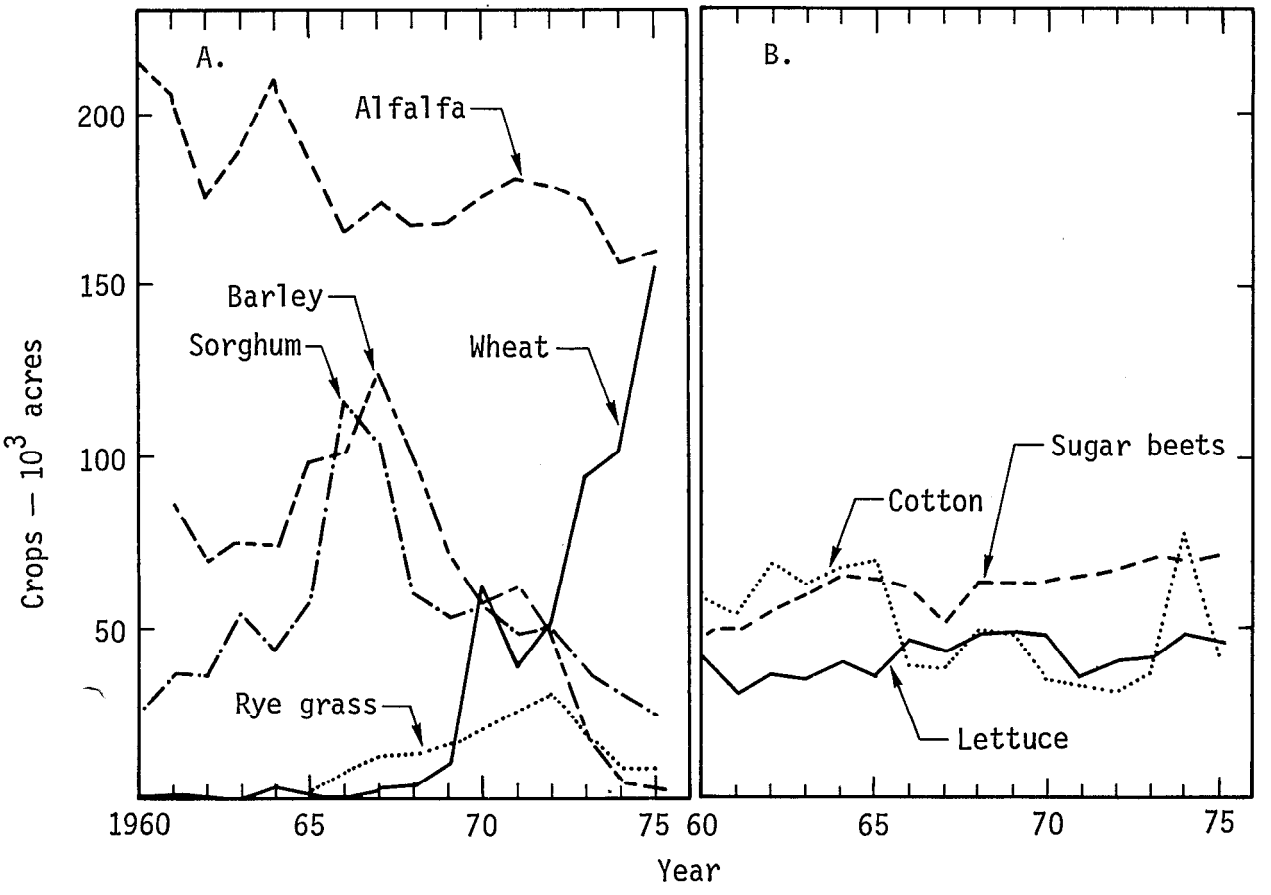


Fig. 4.2. Annual crop production in acres in the Imperial Irrigation District. A) The changes in the last 15 years in grain production in the Imperial Valley. B) Fluctuations in a vegetable crop (lettuce) and two field crops (sugar beets and cotton) over the last 15 years. Data courtesy of the Imperial Irrigation District.[7]

wheat, sugar beets, lettuce, cotton, and sorghum grain. These 6 crops are grown on 498,000 acres (includes double cropping) out of a total of 585,600 acres for 74 crops in 1975. In Fig. 4.2 we show the yearly variation in acreage for the most prominent crops in the last 15 years.[7] These variations reflect the farmers' responses to market fluctuations in the price of crops and the price of factors of production. Notice the historical growth of wheat and the reduction in sorghum and barley in recent years. In Fig. 4.3, the planting and harvesting schedules for Imperial Valley are displayed.[8,9] From this figure, it appears that most vegetable crops are planted in the fall months, mature during the fall and winter, and are then harvested in the winter and spring. Lettuce, a major crop, is harvested in the early winter (December and January). Wheat and sugar beets are harvested in spring. Good success has been

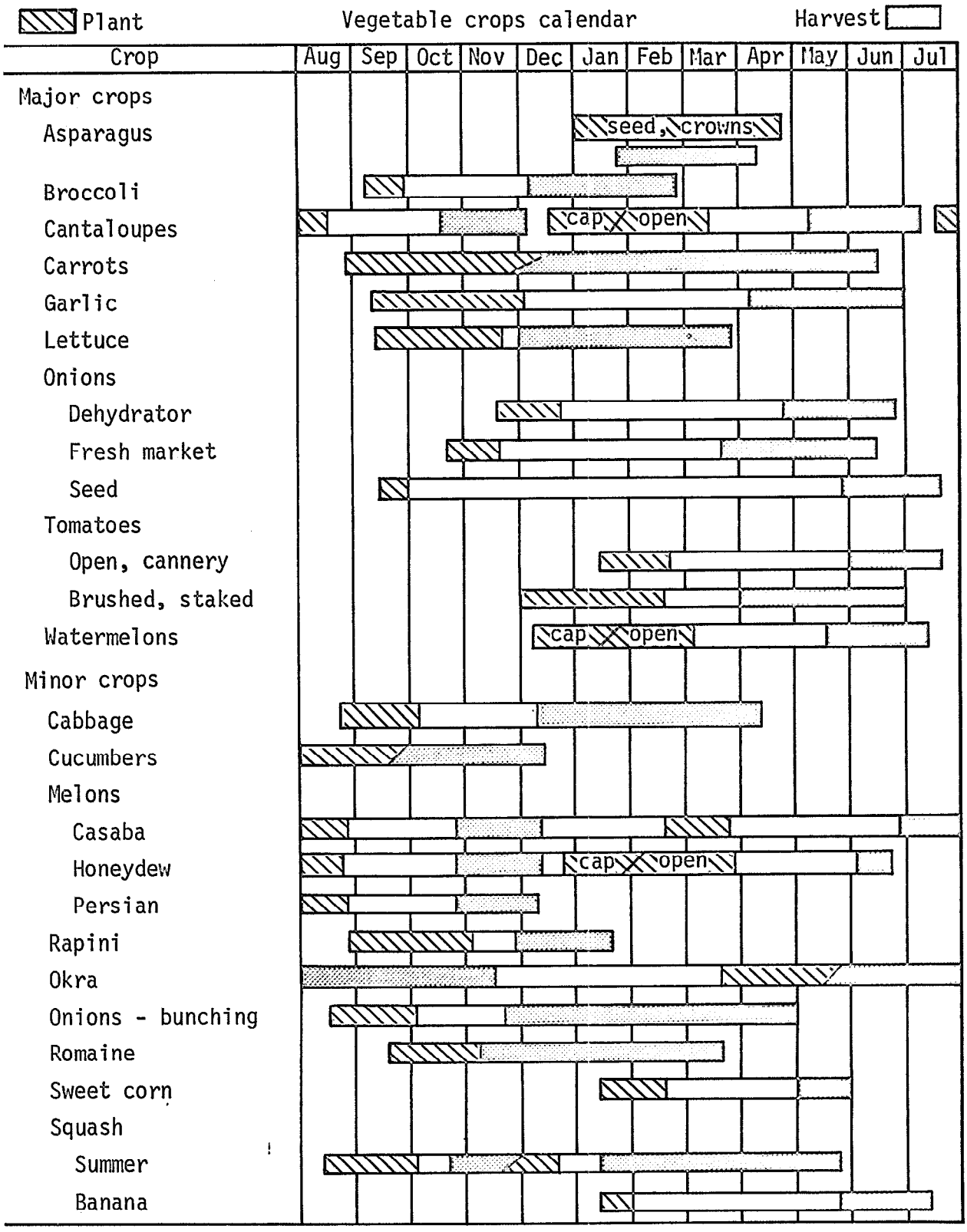
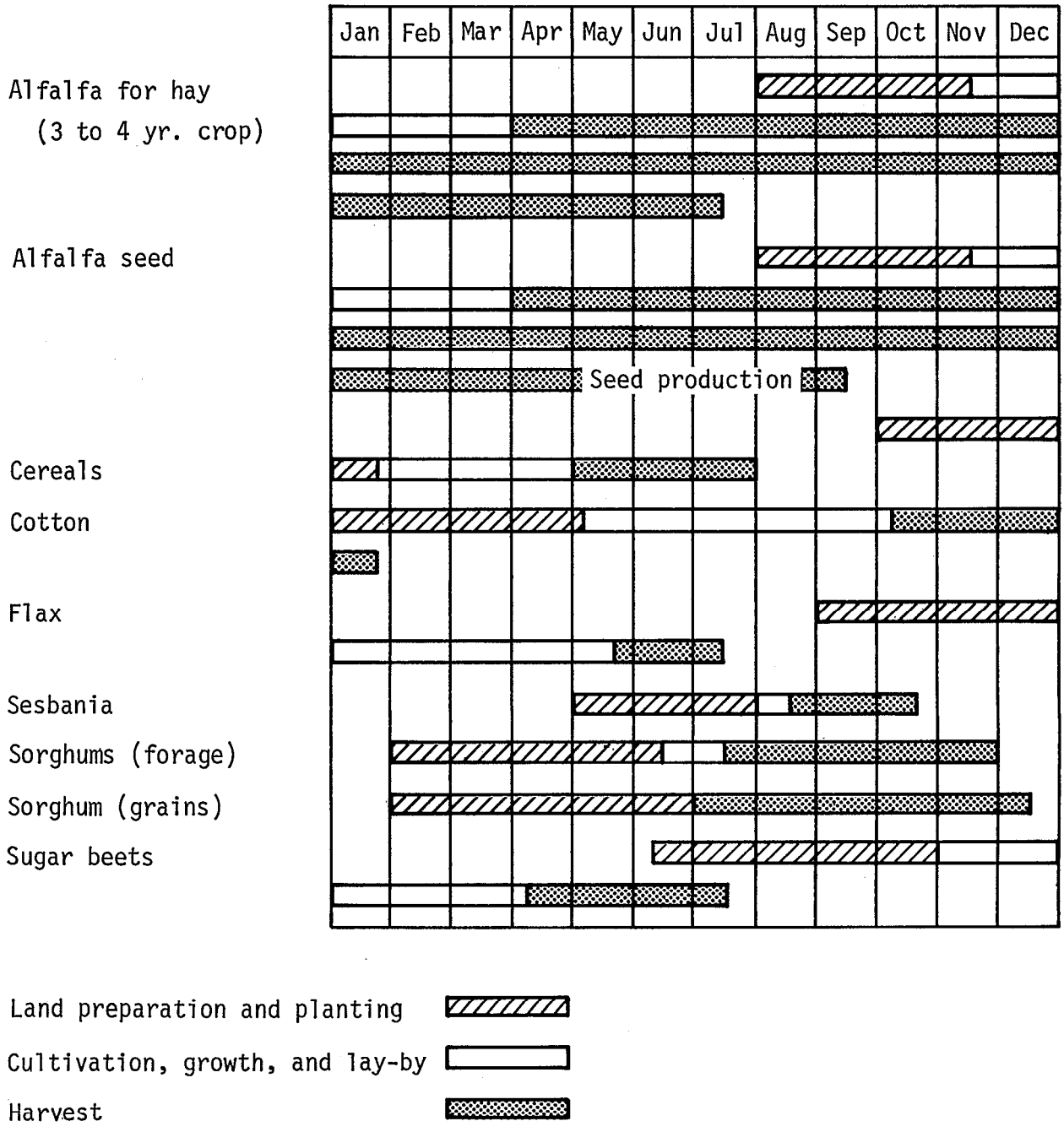


Fig. 4.3. Production calendars for Imperial County crops.[8,9] These calendars show time of year for land preparation and planting, growth, and harvesting of the major crops of Imperial County. A) Vegetable crops. B) Field crops.

Field crops calendar



reported in using this calendar sequence to identify crops from high altitude and earth resources technology satellite (ERTS) images.[2,3] In fact, a newly introduced crop in the Imperial Valley was detected by Johnson and Coleman[2] because it did not fit into this calendar.

Table 4.3[10] lists the major crops in order of acreage for each of the four KGRAs that are either entirely or partly on agricultural land. The

Table 4.3. Major crops grown in KGRAs by approximate relative acreage.[a,b]

KGRA	Wheat	Alfalfa	Sugar beets	Lettuce	Cotton	Sorghum	Melons	Tomatoes	Onions	Rye grass	Sudan grass	Carrots	Asparagus
Niland	1	3	2	6	4	5	9	8	7	10	11		
Brawley	1	2	3	4	5	6	7	8	11	9	10		
Heber	1	2	3	4	6	5	7	9	8	10	11	13	12
East Mesa	2	1	3	4	5	6	7			9		8	

[a]Reference 10.

[b]Numbers refer to relative order of each crop's acreage in that KGRA; 1 represents the greatest acreage.

pattern is quite consistent for each KGRA compared to the valley average taken as a whole.

In Table 4.4,[10] are listed the water requirements, harvest time, and biocide applications for each major crop. Notice that cotton is defoliated once each year.

Soils and Salinity

Most of the soils of the Imperial Valley are alluvial deposits of the Colorado River in the Salton Trough. These were deposited at the time that the Imperial Valley was part of the Colorado River delta. The deposits are up to 20,000 feet deep.[5,11] No soil profile exists. Instead, the horizons are those of deposition, not true horizons of soil development.[12] This accumulation of alluvial material, mainly clays with sand lenses, means that drainage is poor with no gravel or sand strata extending over any

Table 4.4. Major crops in the Imperial Valley with water requirements, harvest dates, and biocide applications.[10]

Crop	Water requirements, ft	Harvest	Pesticides
Wheat	3	May, June, July	1 Herbicide application 1 Insecticide application
Alfalfa	7	All Year	1 Herbicide application 4 Insecticide applications
Cotton	5.5	Nov. through Feb.	2 Herbicide applications 10 Insecticide applications 1 Defoliation
Sorghums	4	July through Nov.	1 Herbicide application 1/2 Insecticide application
Sugar beets	6	April through July	1 Herbicide application 5 Insecticide applications
Asparagus	6	Jan. through April	1 Herbicide application 2 Insecticide applications
Melons	3	May, June, Oct.	3 Insecticide applications
Carrots	3.5	Nov. through June	2 Herbicide applications 2 Insecticide applications
Lettuce	4.5	Dec. through April 10	1 Herbicide application 10 Insecticide applications
Onions	4.5	May through June	1 Herbicide application 2 Insecticide applications
Tomatoes	3	May through June	12 Insecticide applications

Table 4.5. Physical and chemical properties of Imperial Valley soil series samples.[4]

	Imperial	Holtville		Meloland	Indio	
Percent of cultivated land	40	20		12	8	
Description[a]	sic	sic	sic-ss	vfsl	l	vfsl-ss
pH	7.7	7.7	7.7	7.6	7.7	8.1
Sand[b] (%)	3.4	10.8	8.0	66.3	21.3	35.6
Silt[b] (%)	49.0	41.1	43.1	23.5	63.3	52.8
Clay[b] (%)	47.6	48.1	48.9	10.2	15.4	13.1
Field capacity[b] (%)	34.9	32.1	32.4	10.7	20.7	16.5
Wilting coefficient[b] (%)	20.9	18.1	18.4	5.4	7.7	7.0
Infiltration rate (in/hr)	0.051±.01	0.092±.039	0.396±.318	0.315±.083	0.208±.116	0.267±.163
Electrical conductivity[c] (mmho/cm)	4.9	6.8	5.0	7.0	5.0	19.0
Cation exchange capacity[c] (meq/l)	34.2	27.5	29.5	13.2	15.5	14.4
Exchangeable Na[c] (%)	14	12	21	15	30	26
Exchangeable K[c] (%)	4	5	4	3	6	4
Exchangeable Ca[c] (%)	23	30.5	24.3	32.4	21.4	26.9
Exchangeable Mg[c] (%)	11.9	19.6	12.0	19.7	15.1	28.0

[a]sic = silty clay, ss = sandy substrate, vfsl = very fine sandy loam, l = loam.

[b]A and C1 horizon.

[c]Top 12 to 17 in.

appreciable area. This in turn has meant that salt has accumulated in the system and can rise to the rooting zone.[5] In well-managed soils in the Imperial Valley, typical values of soil salinity are 3 to 4 mmhos electroconductivity (soil extract) in the top foot with up to 7 to 8 mmhos at a depth of 2 to 3 feet.[13]

Perrier et al.[4] have classified the soils in the irrigated area of the Imperial Valley as Torriorthents and Torrifluvents. The land is nearly flat with a slope of 5 feet in a mile.[14] Table 4.5 lists the 6 phases in 4 soil series that make up 80% of the cultivated area. This table is abstracted from Perrier et al.[4] As expected, the sandy soils have the lowest water capacity (field capacity minus wilting coefficient) and the highest infiltration rates. The exception is that Holtville silty clay over a sandy substratum has a high infiltration rate. The Imperial and Holtville soils had cation exchange capacities typical of arid region soils; Meloland and Indio soils have cation exchange capacities typical of humid regions soils.[15]

Soils with more than 15% of their total exchange capacity occupied by Na are classified as saline-alkali. Those with less than 15% are classed as saline. In both classifications the pH of the soil is less than 8.5. More detailed soil analyses can be found in Ref. 4.

The Imperial Irrigation District[16] has described the soil characteristics and qualities for all of Imperial County. Summarized in Table 4.6 are some aspects of their descriptions of agricultural land. Note that they classify the soil types into associations and that there is not a one to one correspondence between this classification and the nomenclature of Perrier et al. In all these soils, subsurface drainage must be used to maintain the water table to 4 to 5 feet under irrigation. For all the soils listed, the choice of plants is limited by wetness, since the soils are poorly drained.

Salinity Control Practices and Associated Problems

The major problem of salinity control is attacked by

- The use of relatively good Colorado River water (under 900 ppm) to leach salts from the soil and removing them by a 1400-mi-long drainage system that drains into the New and Alamo Rivers, which in turn empty into the Salton Sea.
- Installation of a tile or plastic drainage system at a depth of 6 ft to carry off excess leaching water.

Table 4.6. Properties of Imperial Soils.[16]

Soil	% Irrigated land	Description[a]	Subsoil permeability	Inherent fertility	Land capability, under irrigation[b]	Infiltration rate when wet
Holtville association, wet	15					
Holtville		sic	Slow over mod. rapid	High	III w 5	Very slow
Glendale-Imperial association, wet	29					
Glendale		ci	Mod. slow	High	II w 5	Very slow
Imperial		sic	Slow	High	IV w 5	
Imperial association, wet	23					
Imperial		sic	Slow	High	IV w 5	Very slow
Gila-Vinton association, wet	9					
Gila		l	Mod. slow	Moderate	II w 5	Slow
Vinton		fsl	Moderate	Low	III w 4	Slow
Meloland-Gila association, wet	13.5					
Meloland		l	Slow	Moderate	III w 3	Very slow
Gila		l	Slow	Moderate	III w 3	Slow
Niland-Imperial association, wet	4					
Niland		gls	Slow	Low	IV w 3	Very slow
Imperial		sic	Slow	High	IV w 5	Very slow

[a] sic = silty clay, ci = clayey loam, l = loam, fsl = fine sandy loam, gls = gravelly loamy sand.

[b] II = soil with some limitations, III = severely limited soil reducing choice of plants, IV = soil with severe limitations, w = principal problem of wetness, 3 = secondary problem of slowly permeable subsoils, 4 = secondary problem of coarse textures, 5 = secondary problem of fine textures.

- Establishment of salt tolerant crops.
- The planting of crops on double-row, sloping beds.[5]

The buried drainage system is subject to failure by clogging. This can occur from silt deposits or root growth[17] or can occur by chemical accumulation of iron and manganese oxides.[18] Physical clogging is removed by mechanical Roto-Rooters.*[17] Chemical clogging is removed by treatment with SO_2.[19] The metal oxide buildups have been observed in all tile types, all valley soils, and in all locations in the valley.[18]

The problem associated with Colorado River water lies in the seasonal variation of the salinity of the water. The lowest salinity level occurs in the summer when the most salt tolerant crops are grown; the lowest salt tolerant crops are grown when the salinity is at its peak in the autumn.[20] Colorado River water contains 1-1/4 tons of soluble salts per acre-foot.

Salts injure plants by exerting an osmotic potential on the plant that requires additional energy for the plant to take water from the soil. This manifests itself in reduced growth and lower yields.[21] Figure 4.4 shows the salt effects on yield of major Imperial Valley crops. The figure is taken from Mayberry.[21]

Livestock Production

Calves are imported from outside the state at a weight of 350 to 400 lbs. These are then raised for slaughter in feedlot operations in the valley. During their stay, they gain approximately 500 lbs. and are fed a diet of mill feed and roughage. The primary cause of livestock death is pneumonia. One quarter of all cattle arriving have shipping fever. Numerous infectious diseases are commonplace in valley feedlots because of contaminated pens and the cattle having varied and, presumably, contaminated origins.[22] Livestock and dairy statistics of 1973-1974 are shown in Table 4.7.[1] Fig. 4.5 depicts livestock trends for 15 years.[23]

Weed Control, Pest Control and Fertilizer

Table 4.8 lists the weeds (grasses, sedges, and broadleaves) found in the Imperial Valley. All are common weeds and are found throughout Imperial County in the

*Reference to a company or product name does not imply approval or recommendation of the product by the University of California or the U.S. Energy Research & Development Administration to the exclusion of others that may be suitable.

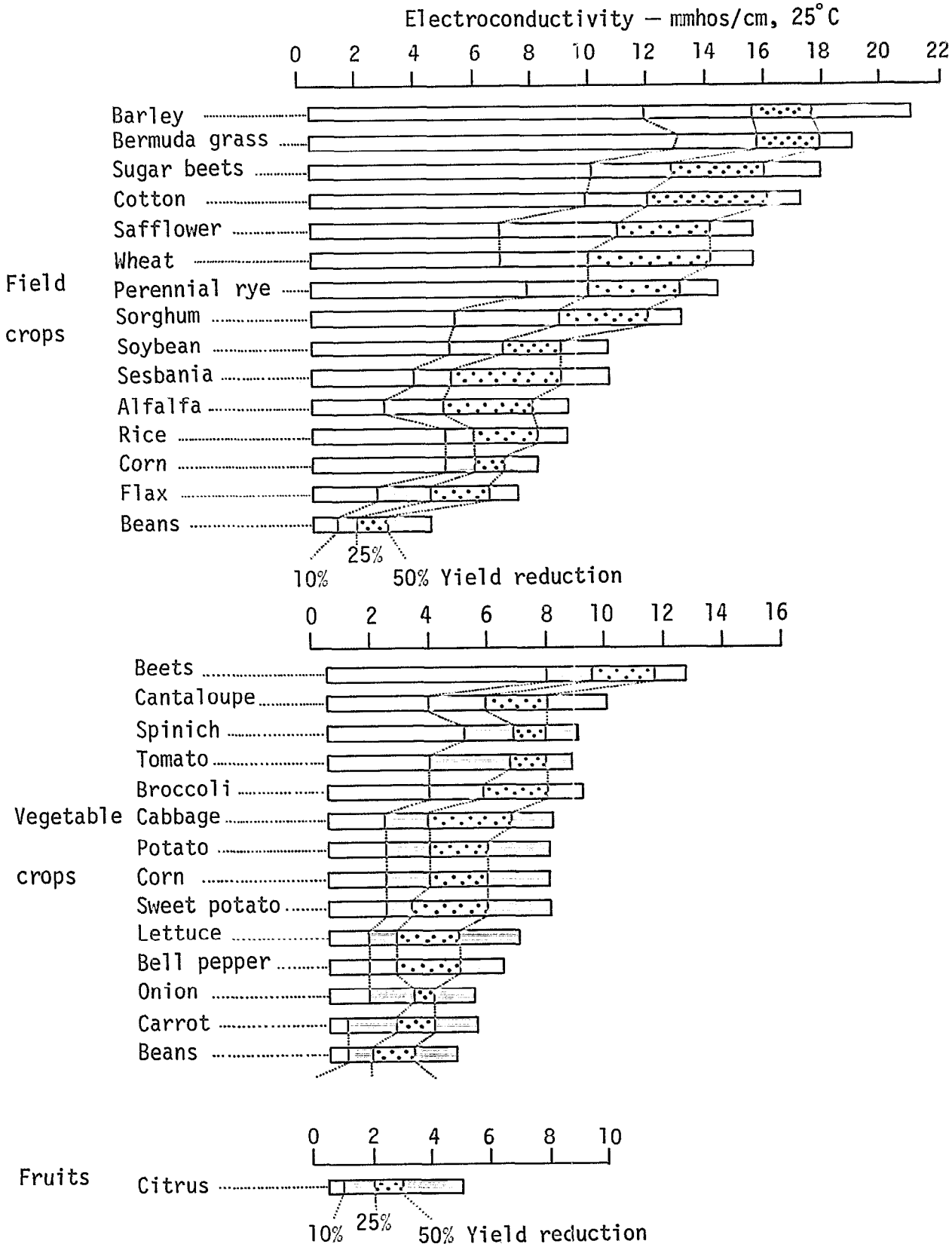


Fig. 4.4. Salt tolerance of crops.[21] The salt tolerances are given for the period of rapid plant growth and maturation. Crops are ranked in order of decreasing salt tolerance. Yield reductions are divided at 10, 25, and 50% reduction.

Table 4.7. Livestock and dairy products of the Imperial Valley.[17]

Livestock and dairy, 1973 to 1974							
	Year	Head	Unit grain	Unit	Total	Per unit	Value
Cattle	1974	720,000	4.97	Cwt	3,578,000	42.21	$ 151,027,000
	1973	798,000	5.34	Cwt	4,261,000	43.76	186,461,000
Sheep	1974	160,000	0.50	Cwt	80,000	38.50	3,080,000
	1973	160,000	0.50	Cwt	80,000	35.91	2,873,000
Wool	1974	162,000	4.0	Lbs.	648,000	0.40	259,000
	1973	180,000	5.10	Lbs.	918,000	0.75	689,000
Milk	1974			Cwt	94,900	8.30	788,000
	1973			Cwt	88,700	6.75	599,000
Miscellaneous Livestock.....	1974						28,000
	1973						22,000
				Total 1974			$ 155,182,000
				Total 1973			190,644,000

Table 4-8. Effectiveness of control of common weeds by herbicides in the Imperial Valley.

		Short residual time (<2 months)											Medium residual time (2-6 months)							Long residual time (>6 months)							
	Season	Banvel	Betamex Betanal	Bustril Bromimal	Butyrac Butoxone	Chem Hoe	Dowpon[b]	Eptam	Furloe	MSMA	RoNeet	Roundup[c]	2, 4-D	Cobex	Dacthal	Enide Dymid	Lorox	Pyramin	Tok	AAtrex	Balan	Caparol	Hyvar[d]	Karmex	Kerb	Milogard	Tolban	Treflan
Grasses and sedge[e]																											
Barnyard grass	S	0	0	0	0	0	1	3	1	3	3		0	3	3	3	2	0	3	3	3	2		2	2	3	3	3
Bermuda grass[f]	S	0	0	0	0	0	2	1	0	0	0		0	0	0	0	0	0		0		0		0	0	0	0	1
Littleseed canary grass	W	0	0	0	0	3	0	3	3		3		0		3	3	3	0	3	3	1	3			3		1	1
Mexican sprangletop	S	0	0	0	0	0	1	2	0	2	3		0	3	2		0	0	2	2	3	0		0	1	2	3	3
Purple nutgrass[f]	S	0	0	0	0	0	0	2	0	3	1		0	0	0	0	0	0	1	1		0		1	0	1	0	0
Rabbitfoot grass	W	0	0	0	0	3	0	3	3		3		0		3	3	3	0	3		3			1	3		1	
Sandbur	S	0	0	0	0	0	0	2		3	2		0		3		2			2	3	1		2		2		3
Volunteer winter cereals		0	0	0	0	3	0	2	3		3		0		3	3	3	0	1	3	1	3		1	3	3	1	1
Water grass	S	0	0	0	0	0	1	3	1	3	3		0	3	3	3	2	0	3	3	3	2		2	2	3	3	3
Wild oats	W	0	0	0	0	3	0	3	3		3		0		3	3	1	0	2	3	1				3	3	1	2
Yellow nutgrass[f]	S	0	0	0	0	0	0	2	0	3	1		0	0	0	0	0	0	1	1		0		1	0	1	0	0
Broadleaves[e]																												
Cheeseweed[g]	W	3	2	3	1		0	2	2		2		2		2	2	2	2	3		1	2		2	1	2		
Curly dock[f]	W	2	2	3	2		0	2	2		0		3					1	1	3					1			
Field bindweed[f]	S	2		0	1		0	0			0		2		0		1	0		0	0	1		0		0		1
Hiter weed (five hook bassia)	S	3	3	3	3		0	3	3				3		2		2			3		2		2	2	3		
Lambsquarters	W	3	3	3	3		0	3	3		2		3	3	3	3	3	3	3	3	3			3	3	3	2	2
London rocker	W	3	3	3	3		0	3	3		1		3		1	0	3	3	3	3	0	3		3	3	3	1	1
Mexican morning glory	S	3			3		0						3	2	0		3			2		3		3		2	1	1
Nettleleaf goosefoot	W	3	3	3	3		0	2	3		2		3	3	2	3	3	3	3	3	2	3		3	3	3	2	2
Pigweed	S	3	3[h]	3	3		0	3	2		0		3	3	2		2	3	3	3	2	3		2	3	3	3	3
Prickly lettuce[g]	W	3	3	3	3		0	2	3		1		3		0	0	3	3	3	3	0	3		3	0		0	0
Puncture vine	S	3			2		0	3		3			3		0		1	0	2	2		2		1		2		2
Purslane	S	3	3	3	3		0	3	3	1	3		3	3	3	3	3	3	3	3	3			3	3	3	3	3
Russian thistle	S	3			3		0	3					3				3			2				1		2		
Shepherds purse	W	3	3	3	3		0	3	3		2		3		1	1	3	3	3	3	1	3		3	3	3		1
Silversheath knotweed	W	3	1	3	2		0	2	2		1		3		1	3	3	2	2	1	1	2		2	2			1
Sour clove[g]	W	3	1	3	0		0	0	0		0		3		0		1	1	0	2	0	2		1	1		0	0
Sowthistle	W	3	3	3	3		0	2	2		1		3		0	0	3	2	2	3	0	3		3	0		0	0
Sunflower	S	3	3	3	3		0	2	3		0		3	0	0	0	3	2	1	3	0	3		3		3	0	0
White horsenettle[f]	S	3			0		0	0			0		3			0				0		1		1		1		0
White sweet clover[g]	W	3	1		0		0	0	0		0		3		0			1	0	2	0	2		1		2		0
Wild beet	W	3	0	3	2		0	3	2		0		3		2		3	0	1		3			3	3			3
Wright groundcherry	S	3	3	3	3		0	3	3		1		3	1	1	0	3	3	3	3	0	3		3		3	0	0

[a] 3 - excellent control 2 - good control 1 - fair control 0 - little or no control

[b] Controls only grasses

[c] Foliar translocated herbicides controls annual weeds and most perennials

[d] All annuals controlled. Perennials require larger doses

[e] All annuals unless noted otherwise

[f] Perennial

[g] Annual or biennial

[h] Betanex controls pigweed. Betanal will not.

irrigated areas. This table was constructed from information taken from Cudney.[24] In Table 4.8, the herbicides used in the valley are listed, grouped according to their persistence in the environment. Herbicides applied to the most common crops are listed in Table 4.9.[24] By comparing these two tables, one can infer the effectiveness of a herbicide in weed control.

Table 4.10 contains the important pests in the Imperial Valley and the crops that they damage. Pests are classified as serious and as possible or occasional pests. If no such information is given then the pest is simply deemed pest. This information is taken from Cudney et al.,[25] Kontaxis,[26] Sharma,[27] and Meister.[28]

In Table 4.11,[29] the total amounts of fertilizers sold in Imperial County in 1975 are listed. In Table 4.12, the amounts of all pesticides and herbicides used in Imperial County in 1975 are shown. These are broken down into pounds used for each crop grown or other use. The total use of the most important pesticides and herbicides for the years 1970, 1971, 1972, 1974, and 1975 is given in Table 4.13. The data in Tables 4.12 and 4.13 were obtained through the courtesy of Ming-Yu Li.[30]

4.2 THE ECOLOGY OF THE SALTON SEA QUASI-MARINE ECOSYSTEM

The Salton Sea, shown on the map in Fig. 4.1, is classified by Hedgepeth[31] and Whitney[32] as a saltern or inland brine. Table 4.14[33,34,35] contains a summary and history of the chemical characteristics of the lake. Irrigation has provided the source of inflow water for the sea since 1907. Between 1960 and 1967, evaporation from the sea averaged 1,330,000 acre-feet (af) annually.[34] Inflow to the sea is about 1,250,000 af from irrigation runoff, 50,000 af from subsurface flow, and 40,000 af from precipitation.[34] The Alamo River from 1960 to 1967 contributed an average of 637,000 af annually, and the New River an average of 413,000 af. Currently the sea is rising. From 1907 to the 1930's, the Alamo channel brought water from the Colorado to Imperial Valley. After the completion of Hoover Dam, the Alamo channel was replaced by the All American Canal.[36] This is still the current means of importation of Colorado water to the valley. In going through the irrigation and drainage system the chemical composition of the water changes, as seen in Table 4.15.[5]

When the sea was first formed, salinity increased sharply by the

Table 4.9. Crop herbicides most commonly used in Imperial Valley.[a,b]

Alfalfa	Eptam, Balan, IPC (Chem Hoe), 2,4-DB, Kerb
Asparagus	Karmex, Princip, Banvel, Lorox
Carrots	Treflan, Lorox, Carrot Oil
Cereals	2,4-D, Buctril, Brominal, Banvel
Cole crops	Tok, Dacthal, Prefar
Cotton	Dacthal, Caparol, Treflan, Cobex, Tolban, Cotoran, MSMA
Lettuce	Balan, Kerb, IPC (Chem Hoe), Prefar
Melons	Prefar, Dacthal
Onions	Dacthal, Sulfuric Acid, Dow Selective, Tok, CIPC (Furloe)
Sorghum	Aatrex, Milogard, Igran, Banvel
Sugar beets	Ro Neet, Tok, IPC (Chem Hoe), Eptam, Betanal Betanex, Pyramin Plus, Furloe
Tomatoes	Devrinol, Enide, Dymid, Trefmid, Prefar, Dacthal, Tillam

[a]Table from Ref. 24.

[b]All items are registered trademarks except IPC, CIPC, MSMA, Ro Neet, 2,4-D, sulfuric acid, and carrot oil.

Table 4-10. Pests[a] of Imperial Valley

ms	Small grains (barley, oats wheat, rye)	Sorghum	Sugar beets	Tomatoes	Watermelon
	s		p	s	s
	m				
	m	s			
			s		
	m				
	mp	s(p)			
			p		s
			p		
		m	p		
	m	m			
			m		
		m			
			m		s
			s	s	
				s	
			p		s
					s
			m		
		p(m)			
			m		
			m		
			m		
				p	
					s
			m		s
			p		
		p	m		
			m	p	
	p	p			
					p
			s		
				s	

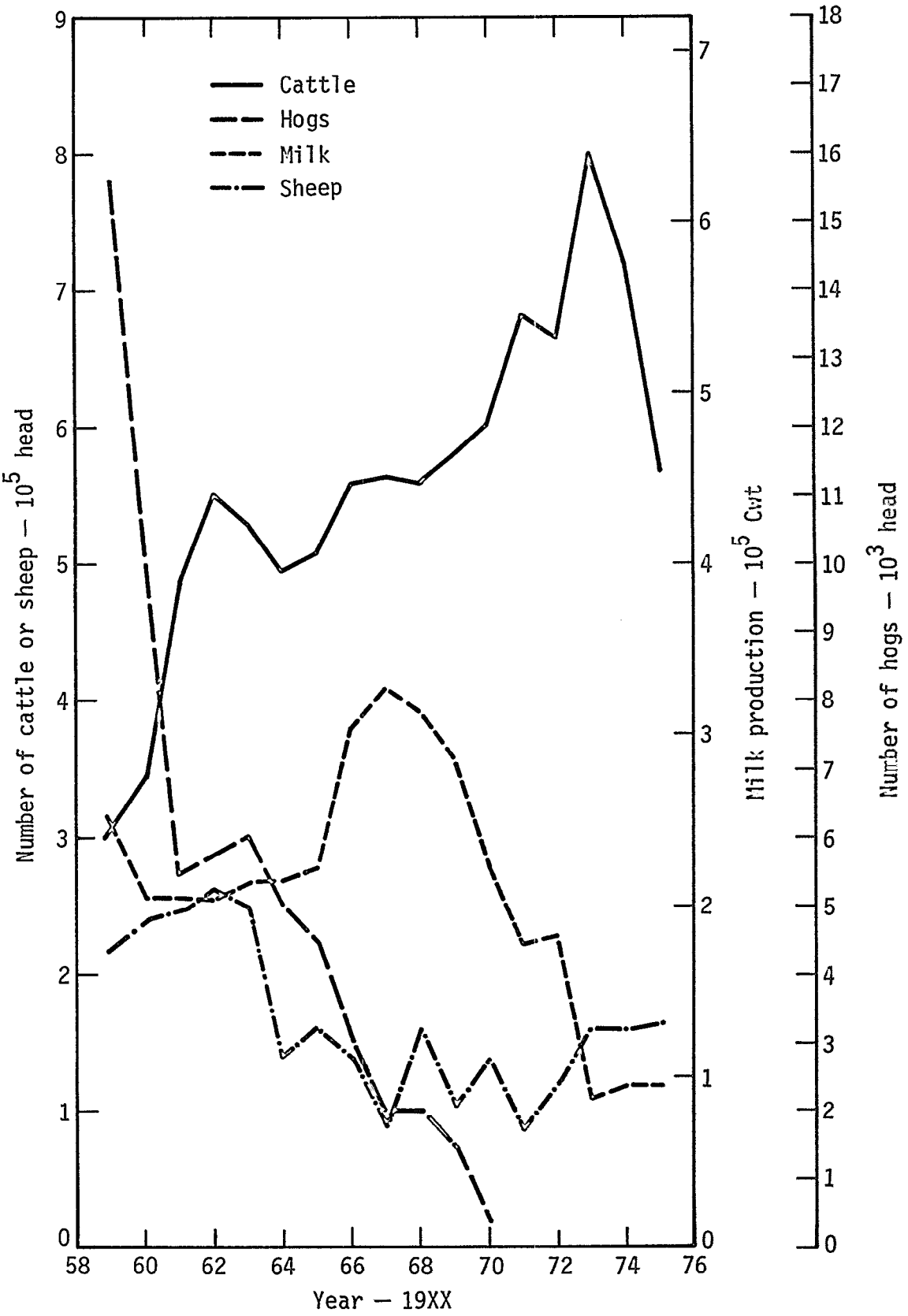


Fig. 4.5. Livestock and dairy statistics for Imperial County; annual livestock turnover and milk production for Imperial County from 1959 to 1975.[23]

Table 4.11. Tonnage of fertilizers and minerals sold in Imperial County in 1975.[a]

Material	Analysis	Material, total tons	Dry	Liquid	Analysis, total tons
	N				67,578
Fertilizer	P_2O_5	240,335	87,361	152,473	30,406
	K_2O				855
Gypsum	$CaSO_4$	47	47	---	39
Iron oxide	Fe	182	182	---	36
Lime-sulfur solution	Calcium polysulfide	4,743	---	4,743	1,163
Soil sulfur	S	902	902	---	844
Dolomite	$CaCO_3$, Mg	2	2	---	---
Limestone	$CaCO_3$	106	106	---	95
Zinc oxide	Zn	9	9	---	6
All other	---	2,860	2,860	---	---

[a]Data from California Department of Food and Agriculture.

dissolution of sea bed deposits of salt directly into the water. The sea's salinity is now gradually approaching 40,000 ppm with about 5.6 million tons of salt accumulating each year.[34]

History of Ecosystem

All fish species in the Salton Sea have been introduced either deliberately or accidentally by man. The first set of fish in the lake were freshwater species. These were carp *Cyprinus carpio*, striped mullet *Mugil cephalus*, humpback sucker *Xyrauchen texanus*, bonytail *Gila robusta*, and rainbow trout *Salmo gairdneri*. These species were common from 1916 to 1929. The carp and bonytail disappeared, and the mullet was scarce, and trout existed only near the inlets by 1929. By 1952 there were only four species of fish in the lake.[32]

Attempts have been made to introduce 29 invertebrate species. These were introduced to establish a food base for the fish. By 1967 there were eight fish species and seven invertebrate taxa. These are listed in Table 4.16. This history is reviewed by Whitney.[32]

Oglesby[37] has observed another copepod species (unidentified

Table 4.12. Pounds of pesticides and herbicides applied in Imperial Valley in 1975.[a]

Uses	Abate	Acephate (orthene)	Aldicarb	Aldrin	Aritrole	Ammonia	Aromatic petroleum solvents	Atrazine
Alfalfa	-	-	-	-	-	-	8,833	-
Asparagus	-	-	-	-	-	-	24	-
Barley	-	-	-	-	-	-	30.6	-
Cabbage	-	-	-	-	-	-	32.8	-
Carrot	-	-	-	-	-	-	199	-
Cauliflower	-	-	-	-	-	-	41.9	-
Citrus	-	-	-	-	-	-	-	-
Corn	-	-	-	-	-	-	-	-
Cotton	-	-	27,870	-	-	-	109,329	-
Cucumber	-	-	-	-	-	-	78	-
Fallow farmland	-	-	-	-	-	-	-	-
Figs	-	-	-	-	-	-	-	-
Forage, hay, and silage	-	-	-	-	-	-	55.5	-
Garlic	-	-	-	-	-	-	-	-
Grasses, grains, and fiber crops	-	-	-	-	-	-	-	-
Lettuce (head)	-	774	-	-	-	2.4	17,822	-
Lettuce (leaf)	-	-	-	-	-	-	83.6	-
Melons	-	-	-	-	-	-	872.7	-
Miscellaneous vegetables	-	-	-	-	-	-	4,326	-
Nectarines	-	-	-	-	-	-	11.9	-
Oats	-	-	-	-	-	-	-	-
Onions	-	-	-	-	-	-	3,160	-
Ornamentals	-	-	-	-	-	-	-	-
Other	-	-	-	880	317	-	234	2,604
Safflower	-	-	-	-	-	-	-	-
Sorghum	-	-	-	-	-	-	479	5,472
Squash	-	-	-	-	-	-	653	-
Sugar beet	-	-	12,135	-	-	-	11,062	-
Tomato	-	-	-	-	-	-	3,028	-
Turf	-	-	618	-	-	-	544	-
Turnip	-	-	-	-	-	-	0.9	-
Vector control	0.36	-	-	-	-	-	-	-
Wheat	-	-	-	-	-	-	1,588	-
Total	0.36	774	40,623	880	317	2.4	162,499	8,075

[a]Data from Ming-Yu Li, Environmental Toxicology Center, University of California, Davis.

Table 4.12. Pounds of pesticides and herbicides applied in Imperial Valley in 1975.[a]

Uses	Atrazine, other related	Avitrol 200	Azodrin	Balan	Baygon	Benomyl	Betasan	Bidrin
Alfalfa	-	-	-	3,997	-	-	-	384
Asparagus	-	-	-	-	-	-	-	-
Barley	-	-	-	-	-	-	-	-
Cabbage	-	-	-	-	-	-	-	-
Carrot	-	-	-	-	-	-	-	-
Cauliflower	-	-	-	-	-	-	-	-
Citrus	-	-	-	-	-	-	-	-
Corn	-	-	-	-	-	-	-	-
Cotton	-	-	105,399	-	-	-	-	6,902
Cucumber	-	-	-	-	-	-	-	-
Fallow farmland	-	-	-	-	-	-	-	-
Figs	-	-	-	-	-	-	-	-
Forage, hay, and silage	-	-	-	-	-	-	-	-
Garlic	-	-	-	-	-	-	-	-
Grasses, grains, and fiber crops	-	-	-	-	-	-	-	-
Lettuce (head)	-	-	-	11,207	-	-	300	-
Lettuce (leaf)	-	-	-	-	-	-	204	-
Melons	-	-	-	-	-	210	530	-
Miscellaneous vegetables	-	-	-	-	-	-	-	-
Nectarines	-	-	-	-	-	-	-	-
Oats	-	-	-	-	-	-	-	-
Onions	-	-	-	-	-	-	-	-
Ornamentals	-	-	-	-	-	-	-	-
Other	137	0.1	-	-	110	-	-	-
Safflower	-	-	-	-	-	-	-	-
Sorghum	288	-	-	-	-	-	-	-
Squash	-	-	-	-	-	21	-	-
Sugar beet	-	-	-	-	-	-	-	-
Tomato	-	-	-	-	-	-	2,372	-
Turf	-	-	-	-	-	-	-	-
Turnip	-	-	-	-	-	-	-	-
Vector control	-	-	-	-	-	-	-	-
Wheat	-	-	-	-	-	-	-	-
Total	425	0.1	105,399	15,204	110	231	3,406	7,286

[a]Data from Ming-Yu Li, Environmental Toxicology Center, University of California, Davis.

Table 4.12. Pounds of pesticides and herbicides applied in Imperial Valley in 1975.[a]

Uses	Bromoxynil octanoate	BTB	N-sec-Butyl-4-tert-butyl 2,6-dinitro aniline	Cacodylic acid	Cacbaryl	Carbofuran	Carbolic acid	Carbon tetra-chloride
Alfalfa	-	119	-	-	8,696	16,770	23	-
Asparagus	-	-	-	-	56	-	-	-
Barley	-	-	-	-	-	-	-	-
Cabbage	-	31.6	-	-	-	-	-	-
Carrot	-	-	-	-	520	-	-	-
Cauliflower	-	-	-	-	50	-	-	-
Citrus	-	-	-	-	88	-	-	-
Corn	-	-	-	-	58	-	-	-
Cotton	-	78	320	1,391	13,138	-	-	-
Cucumber	-	-	-	-	32.5	-	-	-
Fallow farmland	-	-	-	-	-	-	-	-
Figs	-	-	-	-	-	-	-	-
Forage, hay, and silage	-	-	-	-	-	-	-	-
Garlic	-	-	-	-	-	-	-	-
Grasses, grains, and fiber crops	-	-	-	-	-	-	-	-
Lettuce (head)	-	2,103	-	-	2,356	-	3	-
Lettuce (leaf)	-	9.9	-	-	-	-	-	-
Melons	-	96	-	-	3,064	-	-	-
Miscellaneous vegetables	-	16.9	-	-	540	-	-	-
Nectarines	-	-	-	-	-	-	-	-
Oats	-	-	-	-	-	-	-	-
Onions	-	-	-	-	-	-	-	-
Ornamentals	-	-	-	-	-	-	-	-
Other	-	-	-	15.45	207.2	-	-	477
Safflower	-	-	-	-	-	-	-	-
Sorghum	-	-	-	-	1,033	-	-	-
Squash	-	-	-	-	158	-	-	-
Sugar beet	-	-	-	-	23,852	-	259	-
Tomato	-	1.9	-	-	118	-	-	-
Turf	11.6	-	-	-	1,007	-	-	-
Turnip	-	0.64	-	-	-	-	-	-
Vector control	-	-	-	-	-	-	-	-
Wheat	17,554	-	-	-	-	-	-	-
Total	17,566	2,458	320	1,406	54,974	16,770	382	477

[a]Data from Ming-Yu Li, Environmental Toxicology Center, University of California, Davis.

Table 4.12. Pounds of pesticides and herbicides applied in Imperial Valley in 1975.[a]

Uses	Chlordane	Chlordane, other related	Chloro-picrin	CIPC	Cobex	Copper dihydrazi-nium sulfate	Copper oxychloride sulfate	Cryolite
Alfalfa	-	-	-	-	-	-	-	-
Asparagus	244	163	-	-	-	-	-	-
Barley	-	-	-	-	-	-	-	-
Cabbage	9.6	6.4	-	-	-	-	-	540
Carrot	-	-	960	280	-	-	-	-
Cauliflower	-	-	-	-	-	-	-	1,425
Citrus	-	-	-	-	-	-	94.6	-
Corn	-	-	-	-	-	-	-	-
Cotton	-	-	-	-	3,147	-	-	-
Cucumber	-	-	-	-	-	-	-	3,997
Fallow farmland	-	-	-	-	-	-	-	-
Figs	-	-	-	-	-	-	-	-
Forage, hay, and silage	-	-	-	-	-	-	-	-
Garlic	-	-	-	-	-	-	-	-
Grasses, grains, and fiber crops	-	-	-	-	-	-	-	-
Lettuce (head)	746	497	-	-	-	-	-	163,572
Lettuce (leaf)	-	-	-	-	-	-	-	-
Melons	-	-	1,684	-	-	-	-	257,596
Miscellaneous vegetables	-	-	-	-	-	-	-	5,375
Nectarines	-	-	-	-	-	-	-	-
Oats	-	-	-	-	-	-	-	-
Onions	50.4	33.6	4,008	440	-	-	-	-
Ornamentals	-	-	-	-	-	-	-	-
Other	771.15	1.1	3.57	-	-	-	-	-
Safflower	-	-	-	-	-	-	-	-
Sorghum	-	-	-	-	-	-	-	-
Squash	-	-	-	-	-	-	-	1,395
Sugar beet	-	-	600	-	-	-	-	-
Tomato	-	-	300	-	-	17.3	-	1,265
Turf	-	-	-	-	-	-	-	-
Turnip	-	-	-	-	-	-	-	-
Vector control	-	-	-	-	-	-	-	-
Wheat	-	-	-	-	-	41	-	-
Total	1,821	701	7,556	720	3,147	58.3	94.6	435,165

[a]Data from Ming-Yu Li, Environmental Toxicology Center, University of California, Davis.

Table 4.12. Pounds of pesticides and herbicides applied in Imperial Valley in 1975.[a]

Uses	Cypromid	2,4-D	2,4-D, alkanol-amine salt	2,4-D, dimethyl-amine salt	2,4-D, dodecyl-amine salt	2,4-D, sodium salt	2,4-D, tetradecyl-amine salt	Dacthal
Alfalfa	-	289	-	-	-	-	-	-
Asparagus	-	-	-	196	-	2,273	-	-
Barley	-	-	538	672	-	-	-	-
Cabbage	-	-	-	-	-	-	-	1,686
Carrot	-	-	-	-	-	-	-	-
Cauliflower	-	-	-	-	-	-	-	335
Citrus	-	-	-	-	-	-	-	-
Corn	-	-	-	-	-	-	-	-
Cotton	-	-	-	-	-	-	-	24,564
Cucumber	-	-	-	-	-	-	-	-
Fallow farmland	-	-	-	-	-	-	-	-
Figs	-	-	-	-	-	-	-	-
Forage, hay, and silage	-	-	-	-	-	-	-	-
Garlic	-	-	-	-	-	-	-	2,690
Grasses, grains, and fiber crops	-	-	-	-	-	-	-	-
Lettuce (head)	-	-	-	-	-	-	-	-
Lettuce (leaf)	-	-	-	-	-	-	-	-
Melons	-	-	-	-	-	-	-	3,671
Miscellaneous vegetables	-	-	-	-	-	-	-	5,959
Nectarines	-	-	-	-	-	-	-	-
Oats	-	-	-	-	-	-	-	-
Onions	-	-	-	-	-	-	-	38,569
Ornamentals	-	-	-	-	-	-	-	-
Other	-	-	25,221	142.6	1,021	-	256	-
Safflower	-	-	-	-	-	-	-	-
Sorghum	-	-	57	-	-	-	-	-
Squash	-	-	-	-	-	-	-	1,546
Sugar beet	-	-	-	-	-	-	-	-
Tomato	340	-	-	-	-	-	-	10,533
Turf	-	-	142	171	-	-	-	-
Turnip	-	-	-	-	-	-	-	1,114
Vector control	-	-	-	-	-	-	-	-
Wheat	-	616	33,585	13,179	-	-	-	-
Total	340	905	59,543	14,361	1,021	2,273	256	90,667

[a]Data from Ming-Yu Li, Environmental Toxicology Center, University of California, Davis.

Table 4.12. Pounds of pesticides and herbicides applied in Imperial Valley in 1975.[a]

Uses	Dalapon, sodium salt	4(2,4-DB) dimethyl-amine salt	DBCP	DBCP, other related	D-D mixture	DDVP	DDVP, other related	1-Decanol or N-decanol
Alfalfa	-	16,669	-	-	-	-	-	-
Asparagus	-	-	-	-	-	-	-	-
Barley	-	-	-	-	-	-	-	-
Cabbage	-	-	-	-	-	-	-	-
Carrot	-	-	828	43.6	38,392	-	-	-
Cauliflower	-	-	-	-	-	-	-	-
Citrus	-	-	-	-	-	-	-	-
Corn	-	-	-	-	-	-	-	-
Cotton	1,647	-	2,794	-	-	-	-	-
Cucumber	-	-	-	-	-	-	-	-
Fallow farmland	-	-	-	-	-	-	-	-
Figs	-	-	-	-	-	-	-	-
Forage, hay, and silage	-	-	-	-	-	-	-	-
Garlic	-	-	-	-	-	-	-	-
Grasses, grains, and fiber crops	-	-	-	-	-	-	-	-
Lettuce (head)	-	-	-	-	32,686	-	-	-
Lettuce (leaf)	-	-	-	-	-	-	-	-
Melons	-	-	-	-	9,547	-	-	-
Miscellaneous vegetables	-	-	-	-	-	-	-	-
Nectarines	-	-	-	-	-	-	-	-
Oats	-	-	-	-	-	-	-	-
Onions	-	-	-	-	26,472	-	-	-
Ornamentals	-	-	-	-	-	-	-	-
Other	85,622	-	-	-	76,800	16.7	1.26	-
Safflower	-	-	-	-	-	-	-	-
Sorghum	-	-	-	-	-	-	-	-
Squash	-	-	-	-	-	-	-	-
Sugar beet	186	-	-	-	32,600	-	-	-
Tomato	-	-	-	-	1,700	-	-	-
Turf	-	-	-	-	-	-	-	-
Turnip	-	-	-	-	-	-	-	-
Vector control	-	-	-	-	-	-	-	0.85
Wheat	-	-	-	-	-	-	-	-
Total	87,455	16,669	3,622	43.6	218,197	16.7	1.26	0.85

[a]Data from Ming-Yu Li, Environmental Toxicology Center, University of California, Davis.

Table 4.12. Pounds of pesticides and herbicides applied in Imperial Valley in 1975.[a]

Uses	DEF	Demeton	Diammonium phosphate	Diazinon	Dicamba, dimethylamine salt	Dicamba, dimethylamine salt, other related	Dichlobenil	2,2-Dichloropropionic acid
Alfalfa	-	3.9	119.6	34,451	-	-	-	-
Asparagus	-	64.45	-	-	-	-	-	-
Barley	-	-	-	-	-	-	-	-
Cabbage	-	-	-	-	-	-	-	-
Carrot	-	-	-	914	-	-	-	-
Cauliflower	-	2.0	-	-	-	-	-	-
Citrus	-	-	38.56	94	-	-	-	-
Corn	-	-	-	17	-	-	-	-
Cotton	60,146	258	290	-	-	-	-	272.6
Cucumber	-	-	-	224	-	-	-	-
Fallow farmland	-	-	-	-	-	-	-	-
Figs	-	-	-	-	-	-	-	-
Forage, hay, and silage	-	-	-	20	-	-	-	-
Garlic	-	-	6.48	-	-	-	-	-
Grasses, grains, and fiber crops	-	-	-	-	-	-	-	-
Lettuce (head)	-	38	174	2,289	-	-	-	-
Lettuce (leaf)	-	-	-	-	-	-	-	-
Melons	-	-	-	1,765	-	-	-	-
Miscellaneous vegetables	-	-	13.1	295	-	-	-	-
Nectarines	-	-	-	-	-	-	-	-
Oats	-	-	-	-	-	-	-	-
Onions	-	-	-	629	-	-	-	-
Ornamentals	-	-	-	75	-	-	-	-
Other	-	-	-	326	34.9	5.63	27.5	-
Safflower	-	-	12.91	-	-	-	-	-
Sorghum	-	135	-	112	50.9	8.21	-	-
Squash	-	-	-	869	-	-	-	-
Sugar beet	-	-	245.5	1,886	-	-	-	-
Tomato	-	858	32.2	1,805	-	-	-	-
Turf	-	-	-	146	-	-	-	-
Turnip	-	-	-	28	191.6	30.9	-	-
Vector control	-	-	-	-	-	-	-	-
Wheat	-	1,241	68.7	-	6,111	985	-	-
Total	60,146	2,600	1,004	45,945	6,389	1,030	27.5	272.6

[a]Data from Ming-Yu Li, Environmental Toxicology Center, University of California, Davis.

Table 4.12. Pounds of pesticides and herbicides applied in Imperial Valley in 1975.[a]

Uses	Dieldrin	Diethyl-amine salt of coconut fatty acid	Dimetho-ate	Dipha-cindne, sodium salt	Diphen-amid	Disodium octaborate tetra-hydrate	Di-Syston	Diuron
Alfalfa	-	-	1,839	-	-	-	16,722	-
Asparagus	-	-	-	-	-	-	-	4,974
Barley	-	-	-	-	-	-	1,342	-
Cabbage	-	-	21	-	-	-	-	-
Carrot	-	-	-	-	-	-	-	-
Cauliflower	-	-	-	-	-	-	-	-
Citrus	-	-	1,786.3	-	-	-	-	-
Corn	-	-	-	-	-	-	-	-
Cotton	85.9	-	454	-	11	-	7,510	29.2
Cucumber	-	-	-	-	-	-	-	-
Fallow farmland	-	-	-	-	-	-	-	-
Figs	-	-	-	-	-	-	-	-
Forage, hay, and silage	-	-	-	-	-	-	-	-
Garlic	-	-	-	-	-	-	-	-
Grasses, grains, and fiber crops	-	-	-	-	-	-	-	-
Lettuce (head)	-	-	1,201	-	-	-	1,521	-
Lettuce (leaf)	-	-	-	-	-	-	-	-
Melons	-	-	1,395.2	-	-	-	-	-
Miscellaneous vegetables	-	-	22.0	-	-	-	-	-
Nectarines	-	-	-	-	-	-	-	-
Oats	-	-	-	-	-	-	47.8	-
Onions	-	-	-	-	-	-	-	-
Ornamentals	-	-	-	-	-	-	-	-
Other	-	-	-	0.01	2	183	-	7,978
Safflower	-	-	29.3	-	-	-	-	-
Sorghum	-	-	-	-	-	-	1,495	-
Squash	-	-	-	-	-	-	-	-
Sugar beet	-	-	-	-	-	-	1,787	-
Tomato	-	-	2,990	-	3,561	-	-	-
Turf	-	-	-	-	-	-	-	-
Turnip	-	-	-	-	-	-	-	-
Vector control	-	-	-	-	-	-	-	-
Wheat	-	0.4	-	-	-	-	33,751	-
Total	85.9	0.4	9,737	0.01	3,574	183	64,176	12,981

[a]Data from Ming-Yu Li, Environmental Toxicology Center, University of California, Davis.

Table 4.12. Pounds of pesticides and herbicides applied in Imperial Valley in 1975.[a]

Uses	DNBP	DNBP, amine	DNBP ammonium	Dylox	Dypene	Endosulfan	Endothall, di(N,N-diethylalkylamine)	Endothall, mono(N,N-diethylalkylamine)
Alfalfa	11,462	707.6	-	3,899	-	4.0	-	-
Asparagus	-	-	-	-	-	-	-	-
Barley	-	-	-	-	-	-	-	-
Cabbage	-	-	-	-	-	98	-	-
Carrot	-	-	-	476	-	-	-	-
Cauliflower	-	-	-	-	-	22.5	-	-
Citrus	-	-	-	-	-	-	-	-
Corn	-	-	-	-	-	-	-	-
Cotton	-	-	-	238	-	3,777	107.6	2,863
Cucumber	-	-	-	-	-	-	-	-
Fallow farmland	518	-	-	-	-	-	-	-
Figs	-	-	-	-	-	-	-	-
Forage, hay, and silage	-	-	-	-	-	-	-	-
Garlic	-	-	170	-	700	-	-	-
Grasses, grains, and fiber crops	-	-	-	-	-	-	-	-
Lettuce (head)	-	-	-	-	-	73,666	-	-
Lettuce (leaf)	-	-	-	-	-	62	-	-
Melons	-	-	-	318.7	-	172	-	-
Miscellaneous vegetables	-	-	-	-	-	206	-	-
Nectarines	-	-	-	-	-	-	-	-
Oats	-	-	-	-	-	-	-	-
Onions	-	-	290	-	-	-	-	-
Ornamentals	-	-	-	-	-	-	-	-
Other	2,955	-	-	-	-	-	-	-
Safflower	-	-	-	-	-	-	-	-
Sorghum	-	-	-	-	-	-	-	-
Squash	-	-	-	-	-	236	-	-
Sugar beet	-	-	-	2,576	-	370	-	-
Tomato	-	-	-	-	-	2,503	-	-
Turf	-	-	-	-	-	-	-	-
Turnip	-	-	-	-	-	29	-	-
Vecton control	-	-	-	-	-	-	-	-
Wheat	-	-	-	-	-	-	-	-
Total	14,935	707.6	460	7,508	700	81,147	107.6	2,863

[a]Data from Ming-Yu Li, Environmental Toxicology Center, University of California, Davis.

Table 4.12. Pounds of pesticides and herbicides applied in Imperial Valley in 1975.[a]

Uses	Eptam	Ethephon	Ethion	Ethylene dibromide	Ethylene dichloride	Flocmeturon	Folex	Folex, other related
Alfalfa	959	-	-	-	-	-	-	-
Asparagus	-	-	-	-	-	-	-	-
Barley	-	-	-	-	-	-	-	-
Cabbage	-	-	-	-	-	-	-	-
Carrot	-	-	-	86,842	-	-	-	-
Cauliflower	-	-	-	-	-	-	-	-
Citrus	-	-	80	-	-	-	-	-
Corn	-	-	-	-	-	-	-	-
Cotton	-	-	-	-	-	20	12,534	669
Cucumber	-	-	-	-	-	-	-	-
Fallow farmland	-	-	-	-	-	-	-	-
Figs	-	-	-	-	-	-	-	-
Forage, hay, and silage	-	-	-	-	-	-	-	-
Garlic	-	-	-	-	-	-	-	-
Grasses, grains, and fiber crops	-	-	-	-	-	-	-	-
Lettuce (head)	-	-	-	46,363	-	-	-	-
Lettuce (leaf)	-	-	-	-	-	-	-	-
Melons	-	-	-	13,200	-	-	-	-
Miscellaneous vegetables	-	-	-	-	-	-	-	-
Nectarines	-	-	-	-	-	-	-	-
Oats	-	-	-	-	-	-	-	-
Onions	-	-	-	-	-	-	-	-
Ornamentals	-	-	-	-	-	-	-	-
Other	-	-	-	-	1,123	-	-	-
Safflower	-	-	-	-	-	-	-	-
Sorghum	-	-	-	-	-	-	-	-
Squash	-	-	-	-	-	-	-	-
Sugar beet	-	-	-	-	-	-	-	-
Tomato	-	21.6	-	-	-	-	-	-
Turf	-	-	-	-	-	-	-	-
Turnip	-	-	-	-	-	-	-	-
Vector control	-	-	-	-	-	-	-	-
Wheat	-	-	-	-	-	-	-	-
Total	959	21.6	80	146,405	1,123	20	12,534	669

[a]Data from Ming-Yu Li, Environmental Toxicology Center, University of California, Davis.

Table 4.12. Pounds of pesticides and herbicides applied in Imperial Valley in 1975.[a]

Uses	Formetanate hydrochloride	Fundal	Fundal SP	Glyphosate, isopropylamine salt	Gophaside	Guthion	Hexachlorophene sodium salt	Iprodion
Alfalfa	5,385	59	-	-	-	-	-	2,166
Asparagus	-	-	-	-	-	-	-	-
Barley	-	-	-	-	-	-	-	-
Cabbage	-	33	-	-	-	-	-	-
Carrot	-	-	-	-	-	-	-	-
Cauliflower	-	-	-	-	-	-	-	-
Citrus	11.4	-	-	-	-	-	-	-
Corn	-	-	-	-	-	-	-	-
Cotton	-	55,602	3,041	-	-	22,724	877	-
Cucumber	-	-	-	-	-	20	-	-
Fallow farmland	-	-	-	-	-	-	-	-
Figs	-	-	-	-	-	-	-	-
Forage, hay, and silage	-	-	-	-	-	-	-	-
Garlic	-	-	-	-	-	-	-	-
Grasses, grains, and fiber crops	-	-	-	-	-	-	-	-
Lettuce (head)	-	-	-	-	-	-	-	-
Lettuce (leaf)	-	-	-	-	-	-	-	-
Melons	-	-	-	-	-	70	-	-
Miscellaneous vegetables	-	-	-	-	-	-	-	-
Nectarines	-	-	-	-	-	4	-	-
Oats	-	-	-	-	-	-	-	-
Onions	-	-	-	-	-	169	-	-
Ornamentals	-	-	-	-	-	-	-	-
Other	-	-	-	156	4.54	-	-	-
Safflower	-	-	-	-	-	-	-	-
Sorghum	-	-	-	-	-	-	-	-
Squash	-	-	-	-	-	-	-	-
Sugar beet	-	-	-	-	-	-	-	-
Tomato	-	-	-	-	-	631	-	-
Turf	-	-	-	-	-	-	-	-
Turnip	-	-	-	-	-	-	-	-
Vector control	-	-	-	-	-	-	-	-
Wheat	-	-	-	-	-	-	-	-
Total	5,396	55,694	3,041	156	4.54	23,618	877	2,166

[a]Data from Ming-Yu Li, Environmental Toxicology Center, University of California, Davis.

Table 4.12. Pounds of pesticides and herbicides applied in Imperial Valley in 1975.[a]

Uses	IPC	2-Isovaleryl-1-1,3 Indanenedione, calcium salt	Karathane	Kelthane	Kerb	Leptophos	Leptophos, other related	Lignin, sulfonic acid
Alfalfa	57,515	-	-	318	-	-	-	-
Asparagus	-	-	-	-	-	-	-	-
Barley	-	-	-	-	-	-	-	-
Cabbage	-	-	-	-	-	-	-	-
Carrot	-	-	-	-	-	-	-	-
Cauliflower	-	-	-	-	-	-	-	-
Citrus	-	-	-	244.5	-	-	-	54.5
Corn	-	-	-	-	-	-	-	-
Cotton	-	-	-	59.8	-	-	-	-
Cucumber	-	-	-	42	-	-	-	-
Fallow farmland	-	-	-	-	-	-	-	-
Figs	-	-	-	-	-	-	-	-
Forage, hay, and silage	-	-	-	-	-	-	-	-
Garlic	-	-	-	-	-	-	-	-
Grasses, grains, and fiber crops	-	-	-	-	-	-	-	-
Lettuce (head)	14,492	-	-	-	1,588	-	-	-
Lettuce (leaf)	-	-	-	-	-	-	-	-
Melons	-	-	363	6,117	-	-	-	-
Miscellaneous vegetables	-	-	-	-	-	-	-	-
Nectarines	-	-	-	-	-	-	-	-
Oats	-	-	-	-	-	-	-	-
Onions	-	-	-	-	-	-	-	-
Ornamentals	-	-	-	-	-	-	-	-
Other	-	0.33	-	-	-	-	-	-
Safflower	-	-	-	-	-	-	-	-
Sorghum	-	-	-	-	-	-	-	-
Squash	-	-	96.5	-	-	-	-	-
Sugar beet	128,251	-	-	-	-	-	-	-
Tomato	-	-	-	63	-	914.5	136.6	-
Turf	-	-	-	-	638	-	-	-
Turnip	-	-	-	-	-	-	-	-
Vector control	-	-	-	-	-	-	-	-
Wheat	-	-	-	-	-	-	-	-
Total	200,258	0.33	460	6,845	2,226	914.5	136.6	54.5

[a]Data from Ming-Yu Li, Environmental Toxicology Center, University of California, Davis.

Table 4.12. Pounds of pesticides and herbicides applied in Imperial Valley in 1975.[a]

Uses	Lignin, sulfonic acid (Zn, Mn, Fe salts)	Lindane	Linuron	Magnesium sulfate	Malathion	Maneb	Maneb, other related	MCPA, butoxy-ethanol ester
Alfalfa	-	-	-	-	35,965	-	-	-
Asparagus	-	8.5	-	-	1,173	-	-	-
Barley	-	-	-	-	320	-	-	-
Cabbage	-	-	-	-	487	76	-	-
Carrot	-	-	5,398	-	171	-	-	-
Cauliflower	-	-	-	-	143	-	-	-
Citrus	-	-	-	54.5	-	-	-	-
Corn	-	-	-	-	-	-	-	-
Cotton	-	-	-	-	761	-	-	-
Cucumber	-	-	-	-	365	-	-	-
Fallow farmland	-	-	-	-	-	-	-	-
Figs	-	-	-	-	-	-	-	-
Forage, hay, and silage	-	-	-	-	95.9	-	-	-
Garlic	-	-	-	-	108	-	-	-
Grasses, grains, and fiber crops	-	-	-	-	-	-	-	-
Lettuce (head)	-	-	-	-	36,362	3,248	-	-
Lettuce (leaf)	-	-	-	-	20	-	-	-
Melons	-	-	-	-	2,448	8,283	132	-
Miscellaneous vegetables	-	-	-	-	577	-	-	-
Nectarines	-	-	-	-	-	-	-	-
Oats	-	-	-	-	-	-	-	-
Onions	-	-	-	-	4,783	4,953	1,549	-
Ornamentals	-	-	-	-	-	-	-	-
Other	-	-	2.0	-	75	-	-	-
Safflower	-	-	-	-	-	-	-	-
Sorghum	-	-	-	-	-	-	-	-
Squash	-	-	-	-	1,198	-	-	-
Sugar beet	30.1	-	-	-	20,880	-	-	-
Tomato	-	26.3	-	-	542	-	-	-
Turf	-	-	-	-	93.7	-	-	-
Turnip	-	-	-	-	153.6	-	-	-
Vector control	-	-	-	-	-	-	-	-
Wheat	-	-	-	-	-	-	-	310
Total	30.1	34.8	5,400	54.5	106,234	16,560	1,681	310

[a]Data from Ming-Yu Li, Environmental Toxicology Center, University of California, Davis.

Table 4.12. Pounds of pesticides and herbicides applied in Imperial Valley in 1975.[a]

Uses	MCPA, dimethyl-amine salt	MCPA, sodium salt	Meta-Syston	Methonyl	Methyl bromide	Methyl parathion	Mineral oil	Monitor
Alfalfa	24.5	-	176	38,454	-	8,251	-	-
Asparagus	-	-	-	-	-	-	-	-
Barley	-	-	-	-	-	35.5	-	-
Cabbage	-	-	-	575	-	278	-	475
Carrot	-	-	-	414	-	495	-	-
Cauliflower	-	-	-	147	-	118	-	-
Citrus	-	-	-	-	-	-	-	-
Corn	-	-	-	30.8	-	6.0	-	-
Cotton	-	-	-	56,417	-	41,041	-	1,314
Cucumber	-	-	105	18	-	-	-	-
Fallow farmland	-	-	-	-	-	-	-	-
Figs	-	-	-	-	-	-	-	-
Forage, hay, and silage	-	-	-	-	-	-	-	-
Garlic	-	-	-	-	-	-	-	-
Grasses, grains, and fiber crops	-	-	-	-	-	-	-	-
Lettuce (head)	-	-	391	107,844	-	25,653	-	-
Lettuce (leaf)	-	-	-	-	-	27.9	-	-
Melons	-	-	1,026	695	-	69.6	-	-
Miscellaneous vegetables	-	-	7.65	1,896	-	7,552	-	1,777
Nectarines	-	-	4	-	-	-	-	-
Oats	-	-	-	-	-	-	-	-
Onions	-	-	-	82.8	-	287.8	-	-
Ornamentals	-	-	-	452	-	-	-	-
Other	-	-	-	-	496	-	-	-
Safflower	-	-	-	-	-	-	-	-
Sorghum	-	-	18.3	271	-	366	-	-
Squash	-	-	129	82.3	-	-	-	-
Sugar beet	-	-	2,459	85,133	-	49,398	-	-
Tomato	-	-	-	18,219	-	587	-	-
Turf	-	-	70	-	-	-	-	-
Turnip	-	-	-	-	-	-	-	-
Vector control	-	-	-	-	-	-	315	-
Wheat	695	680	-	-	-	514	-	-
Total	720	680	4,386	310,731	496	134,681	315	3,566

[a]Data from Ming-Yu Li, Environmental Toxicology Center, University of California, Davis.

Table 4.12. Pounds of pesticides and herbicides applied in Imperial Valley in 1975.[a]

Uses	MSMA	Naled	Nonycphenol polyoxy-ethylene	Parquat dichloride	Parathion	PCNB	Perthane	Perthane, other related
Alfalfa	-	95.4	-	-	9,300	-	-	-
Asparagus	-	-	-	829	-	-	-	-
Barley	-	-	-	-	15	-	-	-
Cabbage	-	-	-	-	529	-	276	10.2
Carrot	-	-	-	-	550	-	-	-
Cauliflower	-	-	-	-	126	-	-	-
Citrus	-	-	-	-	96	-	-	-
Corn	-	-	-	-	12	-	-	-
Cotton	114	417	-	1,175	60,270	7,049	-	-
Cucumber	-	71.9	-	-	6.5	-	-	-
Fallow farmland	-	-	-	508	-	-	-	-
Figs	-	-	-	-	-	-	-	-
Forage, hay, and silage	-	-	-	-	-	-	-	-
Garlic	-	-	-	-	56.3	-	-	-
Grasses, grains, and fiber crops	-	-	-	-	-	-	-	-
Lettuce (head)	-	-	-	-	31,373	-	21,381	515
Lettuce (leaf)	-	16	-	-	23.3	-	50	4.1
Melons	-	170	-	-	1,054	-	-	-
Miscellaneous vegetables	-	-	-	-	3,411	-	-	-
Nectarines	-	-	-	-	-	-	-	-
Oats	-	-	-	-	-	-	-	-
Onions	-	-	-	-	219	-	-	-
Ornamentals	-	-	-	-	-	-	-	-
Other	5,033	40	-	6.9	-	-	-	-
Safflower	-	-	-	-	-	-	-	-
Sorghum	-	-	-	-	249	-	-	-
Squash	-	388	-	-	337	-	-	-
Sugar beet	-	120	-	30	80,165	-	-	-
Tomato	-	25.5	-	51.4	1,079	-	-	-
Turf	-	-	-	-	-	-	-	-
Turnip	-	-	-	-	-	-	-	-
Vector control	-	-	-	-	-	-	-	-
Wheat	-	-	2.76	-	530	-	-	-
Total	5,147	1,344	2.76	2,600	189,401	7,049	21,707	529

[a]Data from Ming-Yu Li, Environmental Toxicology Center, University of California, Davis.

Table 4.12. Pounds of pesticides and herbicides applied in Imperial Valley in 1975.[a]

Uses	Petroleum distillates	Petroleum distillates, aromatic	Petroleum hydrocarbons	Petroleum oil, unclassified	Phemmediphan	Phorate	Phosphalone	Phosdrin
Alfalfa	299	137	17,379	19,867	-	1,045	-	15,663
Asparagus	3.4	-	198	-	-	-	-	-
Barley	-	228	34.7	-	-	1,608	-	-
Cabbage	1.4	-	35.2	-	-	-	-	123
Carrot	13.3	-	116	179,114	-	-	-	351
Cauliflower	-	-	-	-	-	-	-	21.4
Citrus	-	-	-	-	-	-	336	-
Corn	-	-	-	-	-	-	-	-
Cotton	47.8	167	1,338	2,627	-	1,915	-	-
Cucumber	-	29.8	291	-	-	-	-	198
Fallow farmland	-	-	-	484	-	-	-	-
Figs	-	-	-	-	-	-	-	-
Forage, hay, and silage	-	-	-	-	-	-	-	-
Garlic	-	-	69.2	-	-	-	-	-
Grasses, grains, and fiber crops	-	-	-	-	-	-	-	-
Lettuce (head)	4,425	359	15,547	66.2	-	13,613	-	24,935
Lettuce (leaf)	-	-	14.6	-	-	-	-	196
Melons	16.2	304	359	-	-	-	-	1,175
Miscellaneous vegetables	-	-	135	33.2	-	-	-	588
Nectarines	-	-	-	-	-	-	-	-
Oats	-	19.8	-	-	-	-	-	-
Onions	-	-	315	33.1	-	-	-	1,494
Ornamentals	-	-	-	-	-	-	-	-
Other	4.9	-	48,024	100	-	-	-	-
Safflower	-	-	-	-	-	-	-	-
Sorghum	-	388	39.2	50,979	-	3,797	-	133
Squash	2.8	36.9	337	-	-	-	-	657
Sugar beet	24.6	24.3	119	-	2,132	39,002	-	-
Tomato	-	593	1,185	13.2	-	-	-	1,943
Turf	-	11.2	-	-	-	4,159	-	281
Turnip	-	-	38.6	-	-	-	-	14.7
Vector control	-	-	-	-	-	-	-	-
Wheat	-	6,174	-	-	-	32,169	-	-
Total	4,838	8,472	85,575	253,316	2,132	97,308	336	47,773

[a]Data from Ming-Yu Li, Environmental Toxicology Center, University of California, Davis.

Table 4.12. Pounds of pesticides and herbicides applied in Imperial Valley in 1975.[a]

Uses	Phosdrin, other related	Phospha-midon	Phosphami-don, other related	Phostozid	Potassium pyrophos-phate	Prometone	Prometryne	Propazine
Alfalfa	10,458	-	-	-	-	-	-	-
Asparagus	-	-	-	-	-	-	-	-
Barley	-	-	-	-	-	-	-	-
Cabbage	82	-	-	-	-	-	-	-
Carrot	233	-	-	-	-	-	-	-
Cauliflower	14.3	-	-	-	-	-	-	-
Citrus	-	86	4.04	-	-	-	-	-
Corn	-	-	-	-	-	-	-	-
Cotton	-	-	-	-	-	0.48	21,674	372
Cucumber	132	61.9	2.05	-	-	-	-	-
Fallow farmland	-	-	-	-	-	-	-	-
Figs	-	-	-	-	-	-	-	-
Forage, hay, and silage	-	-	-	-	-	-	-	-
Garlic	-	-	-	-	-	-	-	-
Grasses, grains, and fiber crops	-	-	-	-	-	-	-	-
Lettuce (head)	16,610	-	-	-	-	-	-	-
Lettuce (leaf)	131	-	-	-	-	-	-	-
Melons	782	-	-	-	-	-	-	-
Miscellaneous vegetables	393	-	-	-	-	-	-	-
Nectarines	-	-	-	-	-	-	-	-
Oats	-	-	-	-	-	-	-	-
Onions	996	-	-	-	-	-	-	-
Ornamentals	-	-	-	-	-	-	-	-
Other	-	-	-	0.55	-	1,769	317	-
Safflower	-	-	-	-	-	-	-	-
Sorghum	88.5	-	-	-	-	-	-	372
Squash	439	-	-	-	-	-	-	-
Sugar beet	-	-	-	-	-	-	-	-
Tomato	1,297	2,24.5	7.45	-	-	-	-	-
Turf	187	3,405	112.7	-	-	-	-	-
Turnip	9.8	-	-	-	-	-	-	-
Vector control	-	-	-	-	-	-	-	-
Wheat	-	-	-	-	0.84	-	-	-
Total	31,853	3,778	126	0.55	0.84	1,770	21,991	372

[a]Data from Ming-Yu Li, Environmental Toxicology Center, University of California, Davis.

Table 4.12. Pounds of pesticides and herbicides applied in Imperial Valley in 1975.[a]

Uses	Pyrazon	Pyrazon, other related	Ro neet	Ryamodine alkaloid	Silver butoxy-ethanol ester	Silver isobutyl ester	Simazine	Sodium cacodylate
Alfalfa	-	-	-	-	-	-	-	-
Asparagus	-	-	-	-	-	-	-	-
Barley	-	-	-	-	-	-	1,496	-
Cabbage	-	-	-	-	-	-	-	-
Carrot	-	-	-	-	-	-	-	-
Cauliflower	-	-	-	-	-	-	-	-
Citrus	-	-	-	0.98	-	-	-	-
Corn	-	-	-	-	-	-	-	-
Cotton	-	-	-	-	-	-	-	8,153
Cucumber	-	-	-	-	-	-	-	-
Fallow farmland	-	-	-	-	-	-	-	-
Figs	-	-	-	-	-	-	-	-
Forage, hay, and silage	-	-	-	-	-	-	-	-
Garlic	-	-	-	-	-	-	-	-
Grasses, grains, and fiber crops	-	-	-	-	-	-	-	-
Lettuce (head)	-	-	-	-	-	-	-	-
Lettuce (leaf)	-	-	-	-	-	-	-	-
Melons	-	-	-	-	-	-	-	-
Miscellaneous vegetables	-	-	-	-	-	-	-	-
Nectarines	-	-	-	-	-	-	-	-
Oats	-	-	-	-	-	-	-	-
Onions	-	-	-	-	-	-	-	-
Ornamentals	-	-	-	-	-	-	-	-
Other	-	-	-	-	4,965	34	56	89.3
Safflower	-	-	-	-	-	-	-	-
Sorghum	-	-	-	-	-	-	-	-
Squash	-	-	-	-	-	-	-	-
Sugar beet	158	25.6	21,557	-	-	-	-	-
Tomato	-	-	-	-	-	-	-	-
Turf	-	-	-	-	-	-	-	-
Turnip	-	-	-	-	-	-	-	-
Vector control	-	-	-	-	-	-	-	-
Wheat	-	-	-	-	-	-	-	-
Total	158	25.6	21,557	0.98	4,965	34	1,552	8,242

[a]Data from Ming-Yu Li, Environmental Toxicology Center, University of California, Davis.

Table 4.12. Pounds of pesticides and herbicides applied in Imperial Valley in 1975.[a]

Uses	Sodium chlorate	Sodium tea	Sodium xylene-sulfonate	Starlicide	Strychnine	Sulfur	Sulfuric acid	Superoxide
Alfalfa	-	-	-	-	10	480,124	-	9,611
Asparagus	-	-	-	-	0.05	-	-	-
Barley	-	-	-	-	0.04	-	-	-
Cabbage	-	-	-	-	-	-	-	-
Carrot	-	-	-	-	0.47	-	-	-
Cauliflower	-	-	-	-	-	-	-	-
Citrus	-	-	-	-	20.5	12,538	-	-
Corn	-	-	-	-	-	-	-	-
Cotton	70,492	-	-	-	-	203,050	-	230
Cucumber	-	-	-	-	0.29	-	-	-
Fallow farmland	-	-	-	-	-	-	-	-
Figs	-	-	-	-	1.31	-	-	-
Forage, hay, and silage	-	-	-	-	-	-	-	-
Garlic	-	-	-	-	-	-	-	-
Grasses, grains, and fiber crops	-	-	-	-	-	-	-	-
Lettuce (head)	-	-	-	-	186	-	-	-
Lettuce (leaf)	-	-	-	-	0.98	-	-	-
Melons	-	-	-	-	2.45	203,503	-	-
Miscellaneous vegetables	-	-	-	-	0.07	-	-	-
Nectarines	-	-	-	-	-	-	-	-
Oats	-	-	-	-	-	-	-	-
Onions	-	-	-	-	-	2,117	41,783	-
Ornamentals	-	-	-	-	-	-	-	-
Other	62.5	27,608	-	11.8	1.18	-	-	-
Safflower	-	-	-	-	-	-	-	-
Sorghum	7,149	-	-	-	0.12	-	-	-
Squash	-	-	-	-	0.22	12,639	-	-
Sugar beet	-	-	-	-	0.07	2,455,879	-	-
Tomato	-	-	-	-	5.24	-	-	-
Turf	-	-	-	-	-	1,225	-	-
Turnip	-	-	-	-	-	-	-	-
Vector control	-	-	-	-	-	-	-	-
Wheat	-	-	0.4	-	4.01	-	-	-
Total	77,704	27,608	0.4	11.8	233	3,371,075	41,783	9,847

[a]Data from Ming-Yu Li, Environmental Toxicology Center, University of California, Davis.

Table 4.12. Pounds of pesticides and herbicides applied in Imperial Valley in 1975.[a]

Uses	Telone	Terbutryn, Igran	Terbutryn, other related	Tok 25	Toxaphene	Trifluralin	Vinyl polymer	Warfarin
Alfalfa	-	-	-	-	-	-	-	-
Asparagus	-	-	-	-	-	-	-	-
Barley	-	-	-	-	-	-	-	-
Cabbage	-	-	-	192	-	30	-	-
Carrot	46,194	-	-	-	-	2,220	-	-
Cauliflower	-	-	-	-	-	16	-	-
Citrus	-	-	-	-	-	-	-	-
Corn	-	-	-	-	-	-	-	-
Cotton	-	-	-	-	-	6,785	-	-
Cucumber	-	-	-	-	-	-	-	-
Fallow farmland	-	-	-	-	-	-	-	-
Figs	-	-	-	-	-	-	-	-
Forage, hay, and silage	-	-	-	-	-	-	-	-
Garlic	-	-	-	-	-	-	-	-
Grasses, grains, and fiber crops	-	-	-	-	-	-	-	-
Lettuce (head)	12,480	-	-	-	568	-	-	-
Lettuce (leaf)	-	-	-	-	-	-	-	-
Melons	14,118	-	-	-	-	165	-	-
Miscellaneous vegetables	4,593	-	-	-	-	72	-	-
Nectarines	-	-	-	-	-	-	-	-
Oats	-	-	-	-	-	-	-	-
Onions	2,212	-	-	727	-	-	-	-
Ornamentals	-	-	-	-	-	-	-	-
Other	-	19.5	1.03	-	-	-	5.54	1.23
Safflower	-	-	-	-	-	-	-	-
Sorghum	-	148.5	7.81	-	-	-	-	-
Squash	-	-	-	-	-	-	-	-
Sugar beet	30,284	-	-	44,473	-	-	-	-
Tomato	-	-	-	-	-	587	-	-
Turf	-	-	-	-	-	-	-	-
Turnip	-	-	-	-	-	-	-	-
Vector control	-	-	-	-	-	-	-	-
Wheat	-	-	-	-	-	-	-	-
Total	109,881	168	8.84	45,392	568	9,875	5.54	1.23

[a]Data from Ming-Yu Li, Environmental Toxicology Center, University of California, Davis.

Table 4.12. Pounds of pesticides and herbicides applied in Imperial Valley in 1975.[a]

Uses	Xylene	Xylene-range aromatic solvents	Zinc	Zinc sulfate	Zineb
Alfalfa	45,331	154	70.9	139	-
Asparagus	-	-	-	-	-
Barley	29.5	-	-	1.31	-
Cabbage	3.06	4.11	1.4	1.0	-
Carrot	692	-	-	0.77	-
Cauliflower	-	40.4	-	-	-
Citrus	70.5	-	-	68.4	-
Corn	13.6	-	-	-	-
Cotton	2,048	199	93.1	589	-
Cucumber	162	-	-	1.76	-
Fallow farmland	-	-	-	1.66	-
Figs	-	-	-	-	-
Forage, hay, and silage	15.0	-	-	-	-
Garlic	-	-	-	-	-
Grasses, grains, and fiber crops	-	-	-	6.59	-
Lettuce (head)	14,742	93,533	10.3	1,137	186
Lettuce (leaf)	34.2	64.6	-	-	-
Melons	2,679	322	-	6.25	-
Miscellaneous vegetables	1,780	245	0.26	8.39	-
Nectarines	-	-	-	-	-
Oats	-	-	-	-	-
Onions	450	7.71	-	24.6	195
Ornamentals	56.3	-	-	-	-
Other	13.8	-	-	-	-
Safflower	-	-	-	-	-
Sorghum	259	-	1.3	0.88	-
Squash	394	426	-	15.2	-

Table 4.12. Pounds of pesticides and herbicides applied in Imperial Valley in 1975.[a]

Uses	Xylene	Xylene-range aromatic solvents	Zinc	Zinc sulfate	Zineb
Sugar beet	10,895	867	50.7	644	-
Tomato	871	1,082	12.8	146	-
Turf	800	-	1.04	87.8	-
Turnip	21	-	-	-	-
Vector control	-	-	-	-	-
Wheat	39.2	-	-	11.9	-
Total	81,401	96,945	242	2,892	381

[a]Data from Ming-Yu Li, Environmental Toxicology Center, University of California, Davis.

calanoid), chironomid larvae along shore pools, Black Mollies present in inlet streams to sea, and a Texas amphipod *Corophium louisianum*.

Food Web Structure

The dominant primary production of food is by single cell phytoplankton. The two most common dinoflagellates are *Exuviella compressa* and *Glenodinium* sp.; the most common diatoms are *Thalassionema nitzschiodes* and *Nitzschia longissima*, with *Cyclotella* sp., *Pleurosigma* sp., *Nitzschia sigmoides*, and *Amphora* sp. being of secondary importance. Finally there is a green algae of the order *Chlorococcales*.[38,39] Table 4.17 lists the species found by Carpelan[38] and his estimation of maximum population size. Carpelan estimated the average carbon fixation to be 0.75 $g/m^3/da$. This is about 4 times greater than the value of 0.175 $g/m^3/da$ reported for Long Island Sound. For the total sea, the rate of carbon fixation would be 175,000 tons/yr, using Carpelan's estimate.

Feeding on the phytoplankton are four types of abundant zooplankton: Copepods *(Cyclops dimorphus)*, barnacle larvae *(Balanus amphitrite denticulatus)*, pile worm larvae *(Neanthes* (or *Nereis*) *succinea)*, and rotifers, *Brachionus plicatilis*. Young[39] found his 1967 collections showed results similar to those of Carpelan's[40] 1954 to 56 collections.

Table 4.13. Recent history of the most important herbicides and pesticides used in Imperial County.[a,b]

	1970	1971	1972[c]	1974	1975
Aldicarb	---	---	---	51,288	40,624
Aromatic petroleum solvents	---	64,642	154,000	269,383	162,499
Atrazine[e]	20,040	2,809	12,600	6,845	8,075
Balan	23,917	13,739	20,000	18,487	15,204
Bidrin[e]	51,679	350	500	44,273	7,286
Bromoxynil octanoate	280	---	---	10,465	17,566
Carbaryl	83,246	35,994	60,000	69,379	54,973
Carbofuran	---	---	70	23,852	16,770
Cryolite	501,507	299,995	330,000	296,514	235,164
2,4-D, alkanolamine salt		33,720	34,000	20,436	59,543
2,4-D, dimethylamine salt	64,732	10,925	57,000	16,536	14,362
Dacthal	49,304	64,140	80,000	84,081	90,668
Dalapon, sodium salt	6,623	91,953	134,000	9,530	87,454
4(2,4-DB) dimethylamine salt	---	19,037	9,950	11,541	16,669
D-D mixture	135,000	290,000	126,000	192,455	218,200
DEF	61,841	561	26,000	135,718	60,146
Diazinon	32,417	25,418	12,000	25,700	45,943
Di-Syston	25,515	20,652	26,000	42,497	64,176
Diuron	1,169	6,115	15,800	15,505	12,980
DNBP	2,520	2,332	16,000	31,356	14,935
Endosulfan	40,841	37,751	69,000	56,597	61,147
Ethylene dibromide	---	598	800	29,937	146,405
Folex	4,838	24	7,800	18,840	12,534
Fundal	---	66	29,000	86,254	55,694
Guthion	46,067	16,362	24,000	47,679	23,618
IPC	123,604	91,205	135,000	102,127	200,257
Malathion	146,583	96,809	135,000	120,702	106,252
Maneb	46,401	1,973	12,000	7,668	16,561
Methonyl	142,339	45,635	160,000	285,569	310,733
Methyl bromide[e]	62,717	21,584	20,000	1,366	496
Methyl parathion	205,947	112,129	193,000	153,363	134,680
Parathion	179,154	80,408	160,000	241,690	189,400
Perthane	148,760	34,969	32,000	57,840	21,707
Petroleum hydrocarbons	---	1,380,000	1,719,000	214,087	85,385
Petroleum oil, unclassified	---	NA[b]	71,000	231,980	253,315
Phorate	116,349	NA	170,000	80,809	97,303
Phosdrin	40,009	29,819	87,000	51,005	47,772
Phosdrin, other related	---	15,438	45,000	33,986	31,855
Prometryne	10,899	8,908	10,400	25,834	21,991
Ro Neet	3,817	2,128	905	9,293	21,557
Sodium chlorate	27,797	1,871	163,000	98,300	77,704
Sodium tea	---	38,069	47,000	5,964	27,608
Sulfur	1,450,636	549,905	1,231,000	449,595	3,371,075
Sulfuric acid	---	72,304	9,000	83,328	41,783
Telone	85,789	246,232	200,000	63,640	109,881
Tok 25	21,795	22,963	32,000	26,205	45,392
Xylene	---	26,910	68,000	53,630	81,401
Xylene-range aromatic solvent	---	29,493	46,000	42,072	96,945

[a]Data courtesy of Ming-Yu Li, Environmental Toxicology Center, University of California, Davis, California.

[b]Numbers are in lb. All materials of total use greater than 10,000 lb in 1975 are included. The values are for all registered compounds and applications done under contract to commercial pesticide firms.

[c]Data was poor for 1972; these are estimates. Data for 1973 were unavailable.

[d]Lines mean no values reported for that year.

[e]Included because of historical importance.

[f]NA = not available (missing data).

Table 4.14. Chemical constitution of Salton Sea water.

Year	Ca	Mg	Na	K	CO_3	HCO_3	SO_4	Cl	% TDS
1907[a]	2.7	1.8	30.4	0.63	1.8[b]	--	13.0	46.5	3.65
1910[a]	2.3	1.6	30.8	0.58	1.1	--	12.6	46.5	6.04
1913[a]	2.0	1.6	32.2	0.35	1.1	--	12.4	47.3	10.0
1916[a]	1.8	1.7	32.1	0.35	0.69	--	12.6	47.8	16.47
1929[a]	1.4	4.1	27.2[c]	--	0.71	--	9.5	44.3	14.43
1945[a]	2.3	2.5	30.4	--	0.55	--	18.5	43.5	37.37
1948[a]	2.0	2.5	29.2	0.47	0.05	0.42	18.7	42.0	40.43
1955[a]	2.3	2.8	29.5	0.67	0.06	0.47	20.2	42.8	33.68
1967[d]	2.6	3.1	28.6	0.50	0.008	0.51	22.6	39.5	33.38
1972[e]	2.3	2.9	27.5	0.54	0	0.51	24.5	39.4	40.2
1974[e]	2.5	2.9	27.9	0.60	0.10	0.33	22.9	39.4	39.0
Ocean	1.2	3.7	30.6	1.1	--	0.04	7.7	55.5	34.5

[a]Data from Carpelan.[33]

[b]CO_3 + HCO_3.

[c]Na + K.

[d]Data from California Department of Water Resources.[34]

[e]Data from Spenser.[35]

Table 4.15. Salt constituents of inflow and outflow of Imperial Valley Irrigation System.[5]

Ion	Inflow, %	Outflow, %
SO_4	41	32
Na+K	17	22
Cl	16	30
Ca	12	8
HCO_3	11	5
Mg	4	4

Table 4.16. Fish and invertebrates of the Salton Sea and their origin.[32]

Common name	Scientific name	Introduced directly	Date	Introduced through irrigation canals	Native fauna
Fishes					
Orangemouth corvina	Cynoscion xanthulus	X	1950-56		
Sargo	Anisotremus davidsoni	X	1951		
Gulf croaker	Bairdiella icistius	X	1950-51		
Mudsucker	Gillichthys mirabilis	X	1930		
Striped mullet	Mugil cephalus			X	
Threadfin shad	Dorosoma petenense			X[a]	
Mosquitofish	Gambusia affinis				X[b]
Desert pupfish	Cyprinodon macularius				X
Invertebrates					
Pile worm	Neanthes succinea	X	1930		
Amphipod	Carinogammarus mucronatum	X	1957		
Barnacle	Balanus amphitrite	X	1944		
Copepod	Cyclops dimorphus				X
Nematod	Spilophorella sp.				X
Rotifer	Brachionus plicatilis				X
Protozoa	Numerous species				X

[a]Introduced by man into Colorado River.

[b]Introduced by man into area prior to sea formation.

On the bottom of the sea, there is a large detrital pool caused by the tremendous productivity noted above. This detrital pool and productivity is so high that the sea below a depth of 25 ft, becomes anoxic during the summer months.[41] The pile worm, *Neanthes* (or *Nereis*) *succinea*, lives on the bottom of the sea, feeding on the detritus. Carpelan and Linsley[41] estimated the average standing crops of *Neanthes* to be 300 lb/acre in the spring, 75 lb/acre in the summer, and 125 lb/acre in the fall. The low summer value reflects the anoxic condition in the deep parts of the lake.

The barnacle *Balanus amphitrite* probably feeds mainly on phytoplankton and possibly on zooplankton. The mullet *Mugil cephalus* feeds almost exclusively on phytoplankton while taking in some zooplankton (copepods).[39,42] The mudsucker

Table 4.17. Volume of phytoplankton organisms taken from the Salton Sea.[38]

Species	Volume/cell, μ^3	Maximum number/cm^3 in collections	Volume of maximum number, $\mu^3 \times 10$
Pleurosigma sp.	800	375	0.3
Thallasionema nitzschoides	175	9,000	1.58
Nitzschia longissima	200	56,000	11.2
Cyclotella caspia	400	53,000	21.2
Glenodinium sp.	3,000	41,000	123.
Exuviella compressa	400	63,000	25.
Westella sp.	5	160,000	0.8
Dictyocha sp.	7,000	450	3.1
Eutreptia lanorvii	4,000	1,300	5.2

Gillichthys mirabilis eats mainly punky fly larvae as a young fry (<15 mm), but as an adult its diet is almost entirely *Neanthes* with occasional shore insects.[43] At certain times of the year, *Neanthes* are an important item in corvina diets. The thread fin shad *Dorosoma petenense* eats zooplankton almost exclusively, with small amounts of phytoplankton.[44] The sargo *Anisotremus davidsoni* eats primarily pileworms and, secondarily, barnacles.[39,45] During the summer months when *Neanthes* die from anoxia, *Bairdiella* often die as well.[46] Corvina young, *Cynoscion xanthulus*, feed on copepods, barnacle larvae, and *Neanthes*.[39,47] After attaining a size of 70 to 80 mm, corvina switch over exclusively to fish. They feed on *Bairdiella*, shad and mudsucker.[39,47] The corvina population in 1956 was estimated to be 40,000, and in 1957, 800,000.

This food web information is summarized in Fig. 4.6.

Abnormalities

Several implications can be drawn from observations made by Hendricks[42] and Whitney[46,47] on abnormalities in Salton Sea fish species. First, abnormalities occur at a high rate in the Salton Sea. Because of a large food supply for all species, abnormal fish can survive well. The exception to this rule is in circumstances of strong competition. In this case,

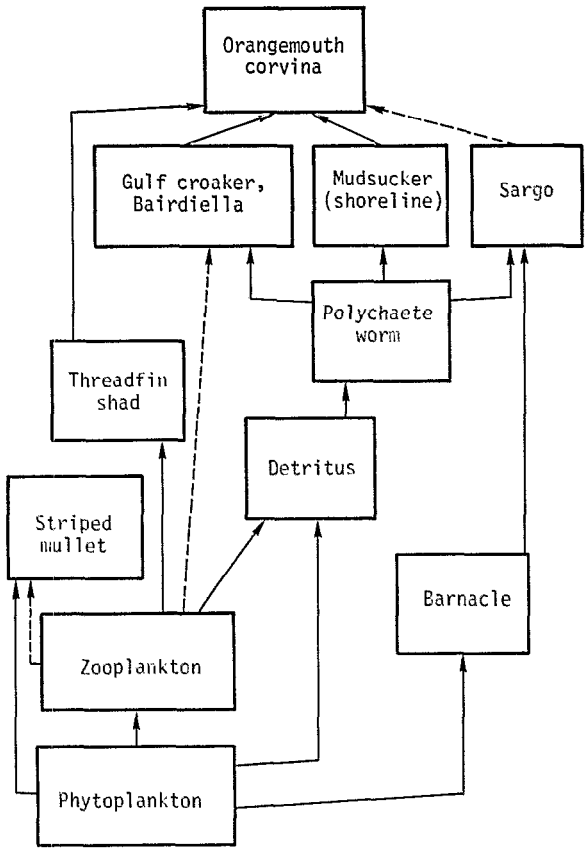


Fig. 4.6. Trophic levels and food web for Salton Sea biota. The major taxa in the Salton Sea food web are shown in their trophic relationships. Solid lines refer to principal diet items; dotted lines refer to occasional diet items.

abnormal fish are weeded out. Specifically, Whitney[46] notes large numbers of abnormalities in *Bairdiella* born in 1952. The fish born in 1953 had a far lower incidence of abnormalities and the abnormality rate of the 1952 group dropped in 1953. Whitney attributes this to increased competition in 1953.

4.3 ENDANGERED SPECIES AND WILDLIFE REFUGES

Although the Endangered Species Conservation Act of 1969 does not set forth specific criteria for determining which species are threatened with extinction, it does direct the Secretary of the Interior to seek the counsel of specialists and agencies with expertise on the subject, and to rely upon their combined judgement.[48] A later reinforced version of the 1969 Act, the Federal Endangered Species Act of 1973, extends federal authority to the Secretary of the Interior over both migratory, resident, and foreign species of plants and animals declared endangered or threatened.

The term endangered species has been redefined and threatened species has replaced the federal designation of rare.

- Endangered species means any species that is in danger of extinction throughout all or a significant portion of its range, other than a species of Class *Insecta*, determined by the Secretary to constitute a pest whose protection under the provisions of the Act would

present an overwhelming and overriding risk to man.

- Threatened species means any species that is likely to become an endangered species within the foreseeable future throughout all or a significant portion of its range.[49]

The Secretary of the Interior and the California Fish and Game Commission have listed five endangered species known to occur in the Salton Sea KGRA; they are the California brown pelican, southern bald eagle, American peregrine falcon, Yuma clapper rail, and the California least tern. Of these, the Yuma clapper rail is the only nesting inhabitant. The others are largely migratory with sightings of the California least tern reported as casual or accidental.[50]

Wildlife Refuges

The Salton Sea KGRA region plays a vital role in providing winter quarters for migratory birds, waterfowl, and other water associated birds for a number of reasons. It is located directly on the Pacific Flyway, the Salton Sea National Wildlife Refuge (Fig. 4.7[51]) and the Imperial Wildlife Management Area are in the vicinity, and extensive marsh cover and mudflats are within the boundaries of the KGRA.

The Salton Sea National Wildlife Refuge was established in 1930 by President Hoover. This refuge is maintained by the U.S. Bureau of Fisheries and Wildlife as a waterfowl resting and feeding area, as provided in treaties with Mexico and Great Britain (for Canada), and to alleviate agricultural crop depredations by waterfowl in Imperial Valley.[52] No other comparable area in the West has the tremendous flocks of shorebirds that use the sea and surrounding area every year. Thirty-five species of shorebirds and 47 species of waterbirds, other than swans, ducks, geese, cranes, and rails, have been recorded.[50]

The California Department of Fish and Game's Imperial Wildlife Management Area consists of 8,400 acres and is farmed for wildlife food production. The Wister Unit comprises 3,900 acres of the refuge and serves 3 basic purposes:

- To help preserve California's waterfowl resource and associated wildlife,
- To attract and hold wintering waterfowl off Imperial Valley's multimillion dollar agricultural crops, and
- To provide public hunting, fishing, nature study, and related uses.[3]

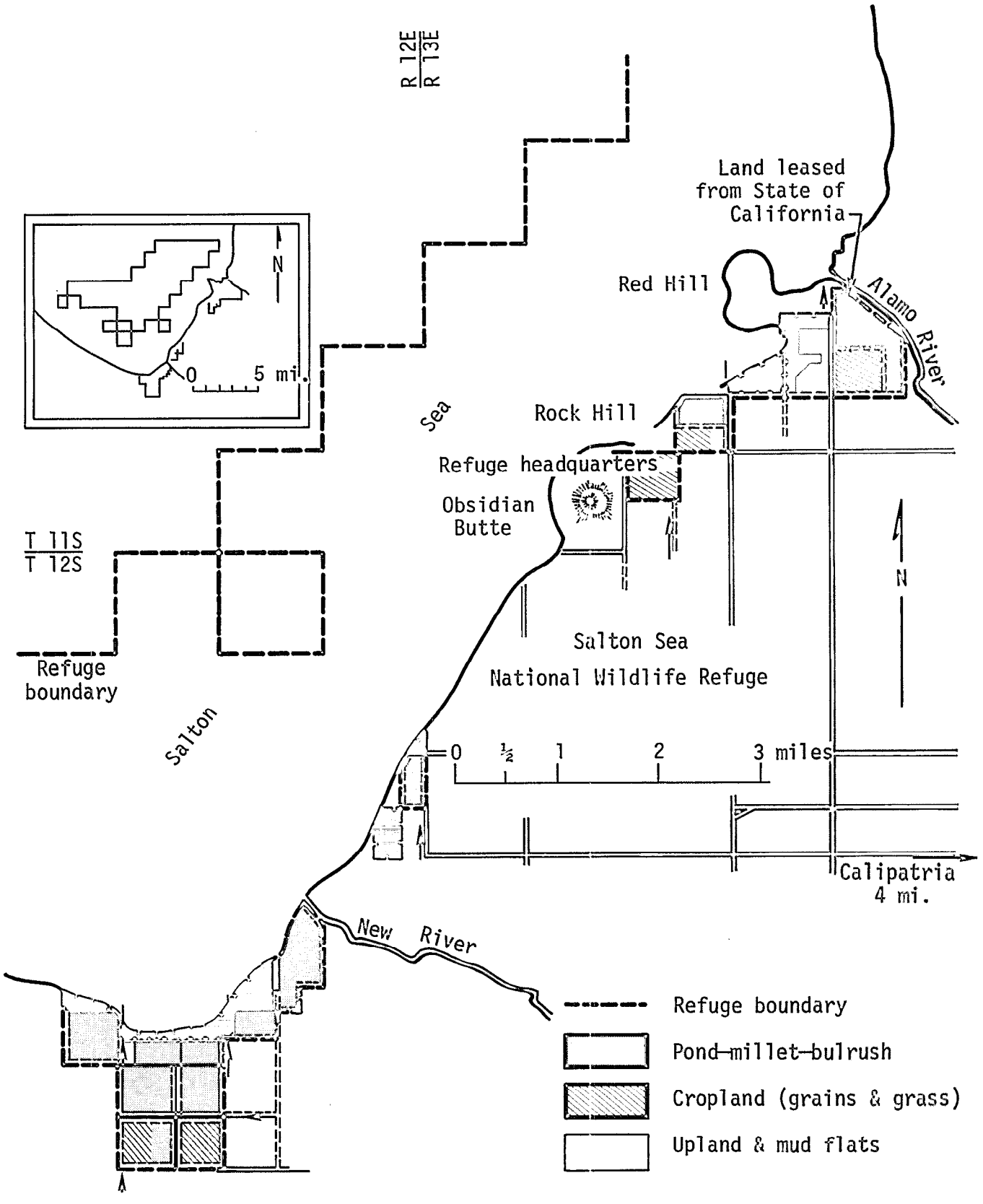


Fig. 4.7. Map of Salton Sea National Wildlife Refuge. Shown are segments of refuge as of June 1971. The refuge is located along southeast shore of the sea. Map taken from U.S. Department of Interior.[51]

The Salton Sea Refuge is also seasonally opened to hunting according to regulations as prescribed by law. McCaskie[53] provides a more detailed accounting of specific shorebird and waterbird use of the Salton Sea.

Endangered Species

Except as noted the following accounts are taken from Refs. 48 and 49 and describe the five endangered species.

- California brown pelican *(Pelecanus occidentalis Californicus)* Description: This is a large, dark gray-brown coastal bird with a bare skin pouch on the underside of its long bill. It flies with its neck and head folded back on its shoulders and with alternate wing flapping and sailing. Adults have mostly white heads and necks, whereas immature birds are dark-headed.

  Distribution: This bird breeds locally on islands along the Pacific Coast from Canada to Mexico. It nests on California's Channel Islands, on the coastal islands off lower California, and in the Gulf of California. Post breeding movement of birds progresses northward along the Pacific Coast in late summer and fall.

  Status: A 1972 survey indicated that the total population is approximately 100,000 birds with 20,000 pelicans frequenting California's Coast from August through November. California's only remaining nesting colony on Anacapa Island (Ventura County, California), currently numbering 400 pairs, is incapable of maintaining itself. The decline of the pelican is attributed to poor reproductive success resulting from collapsed eggs because of thin shells. This is suspected to result from food contamination with DDE (an insecticide) and/or other pollutants.

- Southern bald eagle *(Haliaecetus Leucocephalus Leucocephalus)* Description: The mature bird of the species is a large, hawk-like soaring bird with mainly dark brown plumage and a pure white head and tail. Immature birds are brown, blotched with white all over.

  Distribution: This is the only eagle restricted to North America. It occurs statewide, particularly along the coast and in interior California near large lakes, reservoirs, and wetlands. It nests in the vicinity of large lakes, rivers,

and reservoirs from Fresno County north.

Status: The total number of southern bald eagles has diminished rapidly. Reasons for its decline include irresponsible shooting, increase in human population in primary nesting and feeding areas, removal of nest trees, power line electrocution, environmental pollution, and possible reduced reproduction resulting from pesticide-contaminated food ingested by adults.

- American peregrine falcon *(Falco peregrinus anatum)* Description: This bird is commonly called the duck hawk. It is a medium-sized, blue-gray hawk with long pointed wings and is distinguished from other falcons by its black cap and black cheek patches.

  Distribution: The American peregrine, extinct as a breeding bird east of the Rocky Mountains, breeds in California along the Coast and in higher inland mountains.

  Status: Since the mortality exceeds recruitment, the situation is quite serious. Food chain contamination by persistent pesticides and other contaminants, illegal poaching by falconers, human disturbance, and occasional shooting are contributing to its decline. In the 1940's, the breeding bird population in California was 100 pairs. By 1970 this population had declined to 10 birds, of which 2 pairs produced 4 young. In 1975, encouragingly, 8 pairs were found, 6 of which fledged 14 young.

- California least tern *(Sterna albifrons brownii)* Description: Smallest of the terns, this 9-in-long bird is recognized by its white body, gray wings, black wing tips, black-capped head, and black-tipped yellow bill. Its quick wing beats and hovering action help distinguish it from the larger terns.

  Distribution: Migratory. From April to September it appears along the Pacific Coast from San Francisco Bay to Central Baja California; breeding colonies are distributed discontinuously along the coast. The bird's wintering area is not known although it may include coastal areas of Central or South America.

  Status: The least tern is threatened with extinction because of continuing destruction of its few remaining feeding and

nesting habitats, human disturbance, and animal predators. Nesting colonies require flat areas characterized by complete or nearly complete lack of vegetation, loose substrate, freedom from disturbance, and nearness to an estuary with a good supply of small fish.

Yuma clapper rail *(Rallus longirostris yumanensis)*

Description: In size and appearance the Yuma clapper rail is similar to a small hen, but has a long, slender, slightly decurved bill, and longish legs. This is the smallest of the clapper rails. It is the only one inhabiting freshwater marshes in southeastern California from April to November.

Distribution: This bird is restricted in the breeding season to cattail-tule marshes along the lower Colorado River from the Colorado Delta in Mexico north to Needles, California, in two small marshes along the lower Gila River, in two small marshes immediately south of Phoenix, Arizona, and at the lower end of the Salton Sea. The species is concentrated mainly in Havasu Lake, Cibola, and Imperial National Wildlife Refuges. These birds migrate, but their winter range is unknown. In the Imperial Valley, the major habitats are the deltas of the New and Alamo River and the marshlands scattered between the two deltas. These lie inside the Salton Sea KGRA.

Status: Of the five endangered species listed, the Yuma clapper rail is of prime interest because one of its limited breeding habitats is located in the Salton Sea area. Members of this species occur in small numbers, are very secretive by nature, and inhabit dense marsh habitats where they are seldom seen. At the Salton Sea site, increasing salinity of the water and destruction of vegetation in Colorado River drainage canals has drastically reduced suitable habitats. From observations made in 1969, it appeared that Yuma clapper rails at the Salton Sea appeared to be confined to the extreme southern end, where cattail-tule marshes were not limited by a high salt content of the water.[5] The winter habitat of the Yuma clapper rail is unknown; most sources believe the species to be migratory. Neither direct observations nor taped clapper

rail calls yielded any responses or sightings of Yuma clapper rails along the Colorado River between October and May 1969-70 and 1970-71; clappers further south along the coast of Sonora, Mexico, responded to the same taped calls during all winter months.[53] It was therefore concluded that Yuma clapper rails probably were not present north of the border during the winter.

4.4 VEGETATIVE COMMUNITIES AND WILDLIFE

The Salton Sea, Glamis, Dunes, and East Mesa KGRAs have nonagricultural vegetative communities that provide habitats for various types of wildlife. Descriptions of those communities and their related wildlife are summarized from the Department of the Interior Final Environmental Statement for Geothermal Leasing.[54]

Salton Sea KGRA

Vegetation along the shoreline grows for the most part near freshwater drainages. Vegetation consists mainly of salt brush, salt grass, cattails, nutgrass, salt cedar, cane, arrowweed, and heliotrope. Freshwater marshes exist on the State and Federal Wildlife Refuges with alkali bulrush and cattails.

The deltas of the New and Alamo Rivers have populations of coyote, desert fox, raccoon, bobcat, skunk, badger, muskrat, cottontail, jackrabbit, ground squirrel, valley pocket gopher, desert pocket mouse, and desert kangaroo rat.

Numerous shorebirds and waterfowl inhabit the area as discussed earlier. Other desert species such as roadrunner, cactus wren, and verdin are found in the areas. Amphibians present are southwestern wood home toad, redspotted toad, and bullfrog. Reptiles include zebra-tailed lizard, fringe-toed lizards, rattlesnakes, western blind snake, and desert glassy snake.

Glamis KGRA

Thirty percent of the Glamis KGRA is occupied by the bajada (alluvial fans) mixed community, consisting of ironwood, creosote, ocotillo, mesquite, paloverde, smoke tree, desert willow, desert gold, browneyed primrose, dune primrose, and plantago. The forb season is at its height in the late winter. The soil is stable in this community.

Approximately 55% of the Glamis KGRA is in shifting dunes communities. There are several plant species in the dunes communities that are not found elsewhere in the United States. Herbaceous species such as wild sunflower, croton palafoxia, desert

lily, desert buckwheat are present, as well as sonoran desert trees such as ironwood, desert willow, smoke tree and mesquite.

Fifteen percent of the Glamis KGRA is a creosote forest along the western edge of the KGRA associated with the Coachella Canal. Creosote bush in this area is unusual in nature in both abundance (700 plants/ acre) and size (up to 15 feet). The desert shrub does not go into wilt in this area. This is exceptional for this desert shrub. Ephedra, mesquite, happlopapas, and desert buckwheat are also present and thriving.

These three habitats are the most varied of those in the desert KGRAs. Mammals are similar to East Mesa mammals, but the abundance is greater in the Glamis KGRA. So far, 23 species of mammals, 39 species of birds, 26 species of reptiles, 2 species of amphibians, and 59 species of insects have been identified in the Glamis KGRA. The creosote forest offers a special habitat for desert species. Seeps exist in the forest that contain ponds with complete food chains, including bass as the top carnivore.

Dunes KGRA

Fifty percent of the Dunes KGRA is covered by a creosote community. Densities of creosote shrubs do not exceed 100 plants/acre and existing plants are under high water stress and are often wilted. Fifty percent of the Dunes KGRA is occupied by dunes communities of the type discussed above. These dunes communities are undistinguished.

East Mesa KGRA

Fifty percent of the East Mesa KGRA is covered by creosote community. Ninety percent of the shrub species are creosote with the remaining 10% including ephedra, cheese bush, brittle bush, and coldera. Winter ephemerals are spectacle-pod, desert gold, plantage, and crytantha. Summer ephemerals include a small number of species such as sand mat, gramma, and mustards. Both summer and winter herbaceous vegetation have a long residence time as litter.

Forty percent of the East Mesa KGRA is dunes community similar to those discussed above.

The habitats of the East Mesa KGRA are uniform, and there is not a wide variety of animals present. The species present are abundant, however. The majority of mammals consist of ground squirrels, mice, kangaroo rats, coyote, badger, and bobcat. There are 20 species of reptiles present. Many of these are considered threatened. The desert iguana and western chuckwalla seem to be increasing in the East Mesa

KGRA. Thirty species of birds have been identified, many of them being winter migrants. Over 50 species of invertebrates have been found, and it is thought that over half are endemic to eastern Imperial County.

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Section 5
Geothermal Resources

Donald Ermak and Mary Buchanan

5.1 RESOURCE IDENTIFICATION

The U.S. Geological Survey has designated a number of areas in the State of California as Known Geothermal Resource Areas (KGRAs). Six KGRAs are located within the Imperial Valley. They are the Brawley, Dunes, East Mesa, Glamis, Heber, and Salton Sea KGRAs. Figure 5.1 shows their location, boundaries, and areas. These areas were designated as KGRAs on the basis of temperature gradient measurements made within the valley. An additional area east of Brawley appears to contain a deep-seated heat source; however, this area has not undergone extensive exploration and has not been designated as a KGRA.

Geothermal resources can be classified into five categories: vapor-dominated, liquid-dominated, geopressurized, impermeable dry rock, and magma systems. All the geothermal systems in the Imperial Valley are liquid-dominated. The geothermal fluids are 10 to 30% water vapor by weight when produced, with the remainder of the fluid in the liquid state. The heat energy of the geothermal field is brought to the surface by drilling wells. Generally, after initial stimulation of well flow, the geothermal fluid flows up the well without additional stimulation.

Geothermal resources are often divided into two temperature ranges: above 150°C and below 150°C. Geothermal resources at a temperature of about 150°C may be considered for generation of electricity, while those below 150°C are attractive for space and process heating. Of the six Imperial Valley KGRAs, four have resources above 150°C: Brawley, East Mesa, Heber, and Salton Sea. These areas are also sufficiently large to be of potential economic value. The areas at Dunes and Glamis are probably too small to be economically productive.

Figure 5.1 also shows the regions of Imperial County that are irrigated for agricultural purposes and the boundaries of the Salton Sea. Three of the KGRAs (Brawley, Heber, and Salton Sea) lie almost entirely within the region of irrigated agriculture. About 10% of the East Mesa area is also within this region. In addition, about 50% of the Salton Sea KGRA is under the Salton Sea.

The total land area of the Imperial Valley KGRAs is 254,827

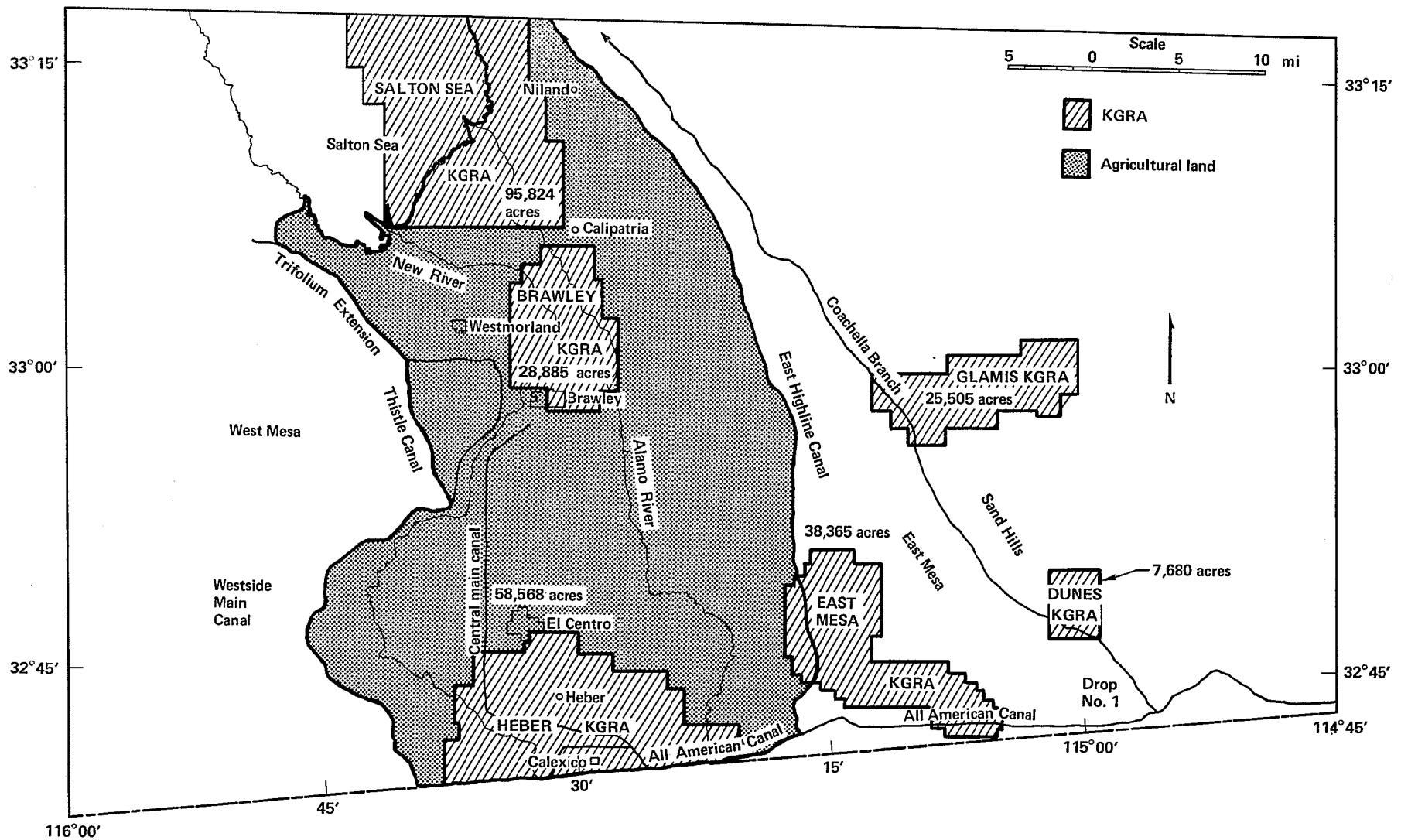

Fig. 5.1. Locations of the six known geothermal resource areas in Imperial Valley.

acres, which is about 9% of the Imperial County land area (2,942,340 acres). About 475,000 acres of land is irrigated for agriculture each year in the Imperial Valley. Of this land about 140,000 acres (approximately 30%) is also designated as KGRAs. The Salton Sea occupies a land area of over 200,000 acres.

5.2 ESTIMATION OF GEOTHERMAL ENERGY RESOURCE

Evaluations of geothermal resource capacity depend upon knowledge of the reservoir temperature, volume, heat capacity, and water-to-rock ratio. In the Salton Trough there is very little hard data. Towse[1] estimates that only 5% of the resources have been explored by the drilling of wells. Consequently, certain assumptions must be made to estimate the capacity of the resources. In the 1968 to 1972 period, a number of estimates that ranged over 5 orders of magnitude were made of the total heat in storage in the Salton Trough.[2-6] In the last year, several estimates have been made that are all within an order of magnitude of each other.[1,7,8,9]

The estimates of Renner et al.,[7] Nathenson and Muffler,[9] Towse,[1] and Biehler[8] are summarized in Table 5.1. Different methods (especially in calculating the reservoir volume) were used to arrive at each set of results. Renner et al. estimated the total heat stored in the Salton Trough to be 175×10^{18} joules (J). Their results were based upon estimates of the reservoir volume to a depth of 10,000 ft, reservoir temperatures above 150°C, and the assumption of a volumetric specific heat of 0.6 cal/cm^3-°C. Nathenson and Muffler estimated the recoverable heat of these resources to be 42.5×10^{18} J by using the figures of Renner et al. and assuming a net recovery factor of 25%. Recovery factor is the product of the fraction of rock that is porous and permeable multiplied by the fraction of thermal energy in the porous permeable part that is recoverable. They used a value of 0.5 for these two factors and only considered resources with a temperature greater than 150°C. The Towse estimate is 20×10^{18} J and considers only geothermal fluids at a temperature of 230°C or greater. He used the temperature gradient maps of Combs[3] to calculate the reservoir volume. Usable geothermal fluid was assumed to extend 1,000 ft below the 230°C isothermal surface or to a maximum depth of 7,000 ft, whichever is less. To complete the calculation, he assumed a well head enthalpy of between 1.0 to 1.3×10^6 J/kg, a specific yield of 0.16 (specific yield = fluid volume/reservoir volume), and a fluid density of 1

Table 5.1. Estimates of the stored heat in the geothermal resources of Imperial Valley.

	Stored heat (10^{18} J)			
	A	B	C	D
Salton Sea	87.9	22.0	11.0	31.2
Heber	46.0	11.5	3.5	12.5
East Mesa	23.0	5.8	3.0	15.6
Brawley	12.6	3.2	1.0	19.8
Glamis	1.7	—	1.0	—
Dunes	2.5	—	0.5	0.8
E. Brawley	0.8	—	—	—
Total	174.5	42.5	20.0	79.1

A = Total heat in rock and water.[7]

B = Heat in geothermal resource. (Data of Renner et al.[7] were used and a specific yield of 0.25 was assumed.)

C = Heat in geothermal resource. (Specific yield of 0.16 assumed.[1])

D = Heat in geothermal resource. (Specific yield of 0.16 assumed.) Three estimates in the ratio 0.67 to 1 to 2 were made. The middle estimate is listed.[8]

gm/cm^3. Biehler's estimates range from 53×10^{18} to 160×10^{18} J. Using Bouger gravity maps, he calculated the reservoir volume on the basis of the residual gravity anomalies associated with each geothermal reservoir. He also assumed a specific yield of 0.16, an enthalpy of 1.3×10^6 J/kg and a fluid density of 1 g/cm^3.

All estimates shown in Table 5.1 are within less than 10 times of each other with the Towse value being the smallest and the Renner value being the largest. Renner and Towse estimate that 50 to 55% of the heat in storage is associated with the Salton Sea field. The Biehler estimate for the Salton Sea area is about 40% of the total for the Salton Trough. Only the Salton Sea, Heber, East Mesa, and Brawley fields are expected to be economical on a commercial basis. The other fields are too small or are too low in temperature.

Production of electrical energy is accomplished by using the high temperature, high pressure geothermal fluid to either directly or indirectly turn a turbine that then runs an electric generator. Not all of the heat energy in the geothermal fluid can be converted to mechanical energy in the turbine. For steam turbines, the fraction of convertible energy depends upon the input and output temperature of the steam. To maximize this fraction, the input temperature must be as high as possible and the output temperature as low as possible. For a geothermal plant, the input temperature cannot be higher than the temperature of the geothermal fluid. Depending upon the temperature of the geothermal fluid, efficiencies from 8 to 18% can be expected from geothermal plants. In contrast, modern fossil fuel plants operate at efficiencies of about 36% by superheating the steam (540°C) to be used in the turbine.

Estimates of the potential electrical energy production by Nathenson and Muffler[9] and those of Towse[1] are given in Table 5.2. Nathenson and Muffler considered conversion to electrical power by the flashed steam process and only considered fluids above 150°C. They used the following conversion efficiencies: 150 to 200°C, e = 0.08; 200 to 250°C, e = 0.10; and 250 to 300°C, e = 0.12. Towse considered several geothermal power technologies: binary, flashed steam, and total flow. The minimum resource temperature considered was 230°C. The conversion efficiencies used by Towse were those of Austin et al.[10] The efficiencies shown in Table 5.2 for Towse's data are the average values calculated from his estimated geothermal heat energy and his estimated electrical energy production. Despite the different assumptions made by these authors, the final estimates for the total potential for electric energy production of the Salton Basin region are in good agreement. They are 4580 MW (Nathenson & Muffler[9]) and 3350 MW (Towse[1]) for a 30-yr period.

5.3 PHYSICAL AND CHEMICAL CHARACTERIZATION OF THE GEOTHERMAL FLUIDS

The physical and chemical characteristics of the geothermal fluids determine its potential for conversion to electric power, the type of conversion technology that can be used (e.g., binary, total flow, etc.), the expected electrical power, and the potential hazards to the environment through the emission of gaseous and liquid wastes. While some data exist for each of the KGRAs, in general the information is quite scanty. Most of the information that has been collected to date is for the Salton Sea and East Mesa

Table 5.2. Estimated electrical energy production, 30-yr equivalent — MW.

	Reference 9			Reference 1	
	e	T	P	e	P
Salton Sea	0.12	340	2787.	0.164	2000.
Heber	0.08	190	973.	All others:	
East Mesa	0.08	180	487.	0.12	1350
Brawley	0.10	200	333.		
Glamis/Dunes/E. Brawley		135	0.		
Total			4580.		3350.

e = Average electrical energy conversion efficiency.

T = Geothermal resource temperature °C.

P = Electrical power in MW for 30-yr period.

KGRAs. Palmer[11] and Hoffman[12] each present the characteristics of about 20 geothermal wells located in the Salton Sea field. The characteristics of six East Mesa wells are given by the Bureau of Reclamation in a 1974 Status report.[13]

Geothermal Reservoir Temperature and Pressure

Renner et al.[7] give representative temperatures for each of the KGRAs in the Imperial Valley (see Table 5.2). On the basis of geothermal fluid temperature, the KGRAs can be graded in decreasing order as Salton Sea, Brawley, Heber, East Mesa, Dunes, and Glamis. The average well bottom temperature of 16 Salton Sea wells taken from Palmer[11] and Hoffman[12] is 286 ±45°C. This value for the average temperature of the Salton Sea KGRA is considerably less than the value used by Renner et al.,[7] (Table 5.2), but still leaves the Salton Sea field as the hottest in the valley. The average temperature of 6 East Mesa wells is 180±13°C. This result is in very good agreement with the temperature used by Renner et al.

Figure 5.2 presents the temperature and hydrostatic pressure profiles of the Bureau of Reclamation's Mesa 8-1 geothermal well. The profiles increase in both temperature and pressure with increased well depth as is typical of geothermal wells.

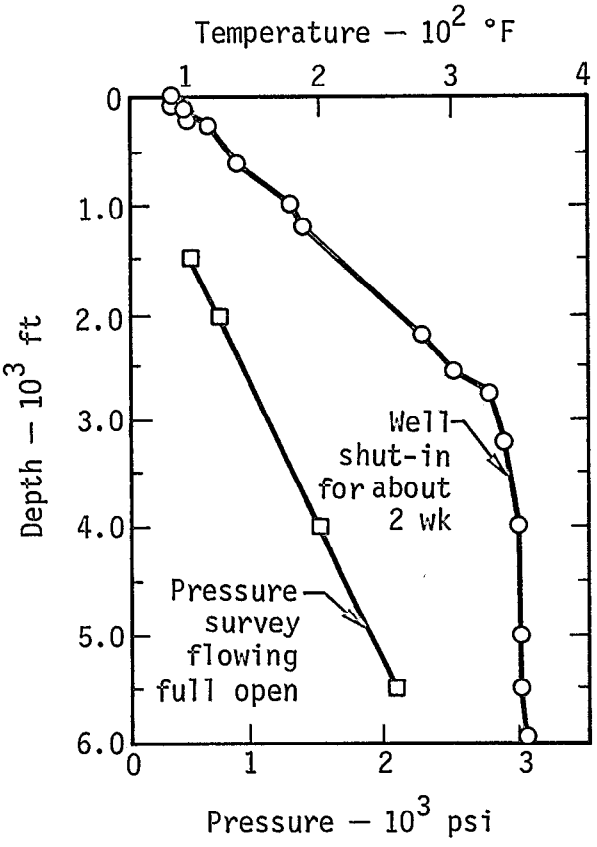

Fig. 5.2. Temperature and pressure profiles for the Mesa 8-1 well, Imperial Valley, California, May 29, 1974.[13]

The hydrostatic pressure at a depth of 6,000 ft is about 2,600 pounds per square inch (psi) in the Salton Sea field and about 2,300 psi in the East Mesa field. Based upon data from six wells, Helgeson[5] indicates that fluid pressures in the Salton Sea field are normal hydrostatic pressures. Presumably this is true throughout the Imperial Valley.[10] The pressure profile of six Salton Sea wells and two East Mesa wells is given in Fig. 5.3 with a curve for pure water as a comparison.

Physical Characteristics at the Well Head

Production rates of geothermal wells depend upon the well-head pressure, well-orifice size, and duration of flow. The well-head temperature and flow rate as a function of well-head pressure are given in Fig. 5.4 for two East Mesa wells. As the well-head pressure is increased the well-head temperature increases; however, the flow rate decreases. The fraction of geothermal fluid that is steam ranges from 10 to 20%. Using thermodynamic considerations, the theoretical available energy from the Mesa 6-1 well is 3.4 MW.

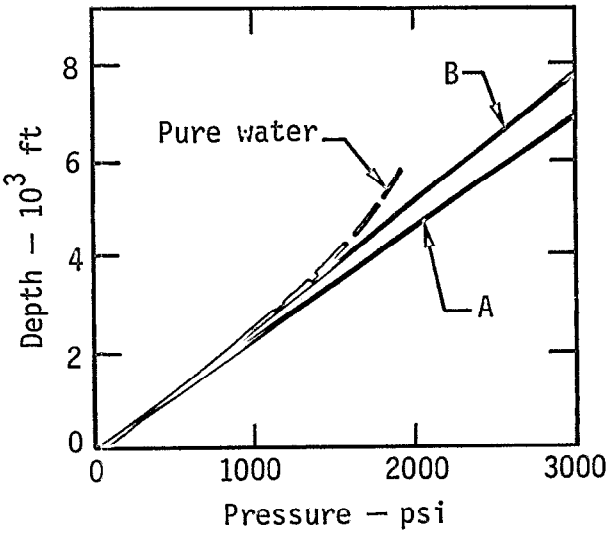

Fig. 5.3. Pressure-depth profiles for selected geothermal wells, 13-September 1974. A = Salton Sea wells, hydrostatic gradient = 0.384 psi/ft; B = East Mesa wells, hydrostatic gradient = 0.434 psi/ft.[10,13]

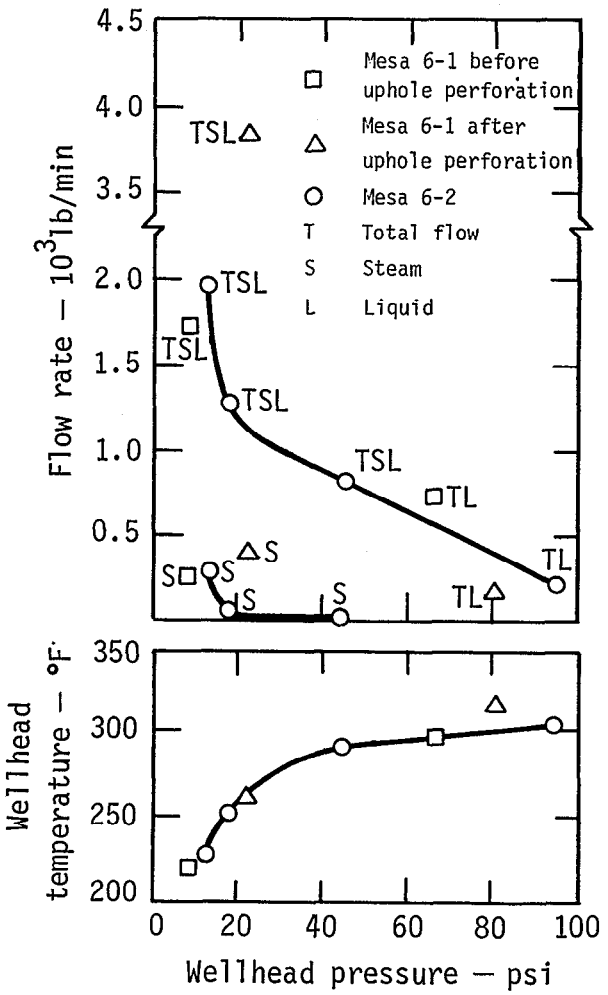

Fig. 5.4. Temperature, pressure, and flow rates for Mesa 6-1 and Mesa 6-2 wells, Imperial Valley, California.[13]

Flow rates for wells in the Salton Sea KGRA are quite high. Palmer[11] presents production characteristics for 10 wells in the Salton Sea field. The average flow rate for these wells is 435,000 lb/hr at an average pressure of 215 psi and an average of 19% steam by weight. The fraction of steam ranged from 10 to 25%. Well orifice size for the 10 wells ranged from 5 1/2-to 8-in diameter. The average fluid enthalpy of 10 Salton Sea wells characterized by Hoffman[12] is 242±26 calories/gram (cal/g). Helgeson[5] reports that several Salton Sea wells have produced for up to 18 months without appreciable decrease in the flow rate, temperature, and enthalpy.

Chemical Composition of the Brines

The usefulness of a liquid-dominated geothermal resource depends on the salinity of the fluid, its thermal properties, and on the ability to bring the fluid to the surface. Fluids that have a high salt content will cause severe corrosion and scaling problems in the wells and support equipment. These problems, if severe enough, will require costly maintenance expenses and can make a power plant uneconomical to operate.

The geothermal fluids in the Imperial Valley KGRAs are generally quite saline. There appears to be a salinity gradient such that the salinity is lowest near the Colorado River side of the valley and increases northwestward toward the Salton Sea. The total dissolved solids (TDS) in the Salton Sea KGRA averages about 210,000 ppm. In the East Mesa KGRA, TDS averages about 2,100 ppm and in the Heber KGRA about 20,000 ppm. For comparison, the salinity of sea water is about 33,000 ppm and the salinity of the Salton Sea is 39,000 ppm TDS.

Table 5.3 summarizes the chemical composition data for geothermal brine collected for the wells in the Salton Sea and East Mesa KGRAs. For some constituents, the standard deviation is as large or larger than the average concentration, indicating a large variance from well to well. In addition, the constituent concentration for a single well often varied by 25 to 50% when measured at different times. One well in the East Mesa that had a TDS content 10 times higher than the other wells was left out of the statistics since it is not considered to be representative of the field.[14]

The brines of the Salton Sea KGRA have extremely high salinity (about 10 times that of sea water). Consequently, while the Salton Sea KGRA is estimated to contain about 50% of the total geothermal resource in the Imperial Valley, it also has the highest salinity. The problems of corrosion and scaling must be overcome before these fluids can be

Table 5.3. Geothermal brine composition of Salton Sea and East Mesa wells.

	East Mesa			Salton Sea		
	$\bar{C}$,[a] ppm		ΔC[b]	$\bar{C}$,[c] ppm		ΔC[b]
TDS	2,120	±	336	214,000	±	98,000
Na	701	±	68	46,000	±	18,000
K	41	±	17	13,000	±	6,500
Ca	39	±	36	21,000	±	9,800
Mg	1.2	±	0.8	374	±	634
HCO_3	532	±	141	2,500	±	2,600
Cl	541	±	80	124,000	±	54,000
SO_4	172	±	45	180	±	230
B	2.8	±	0.6	317	±	199

[a] $\bar{C}$ = Average concentration of 4 wells.[13]

[b] ΔC = Standard deviation among wells (indicates variance among wells).

[c] $\bar{C}$ = Average concentration of 9 wells.[11,12]

used economically for the production of electrical energy.

Noncondensable Gases

A small fraction of the geothermal fluids is composed of noncondensable gases that are ultimately emitted to the atmosphere during the conversion from geothermal heat energy to electrical energy. The fraction of noncondensable gases in the Imperial Valley resources is estimated to be about 1%.[15] While the composition of this gas fraction is highly variable, CO_2 is always the major fraction with lesser amounts of H_2S, H_2, CH_4, NH_3, and N_2.[16] Even though CO_2 constitutes the major fraction of the noncondensable gas emitted from a geothermal plant, the emissions of CO_2 from an equivalent fossil-fuel plant are about 20 times higher.[17]

There are to date no known measurements of the noncondensable gas fraction from the KGRAs in the Imperial Valley. As a crude indicator, the emissions at the Geysers geothermal plant in Sonoma County, California are given in Table 5.4. The Geysers plant is a vapor-dominated system and presently products 502 MWe. The fraction of emitted steam that is noncondensable gas is 0.4% by weight. Also listed in Table 5.4 are the atmospheric emissions of solids in cooling tower drift.

The geothermal emission of major concern is H_2S with possibly NH_3 as a distant second. Hydrogen sulfide is toxic at high concentrations, but these high levels are not expected to occur as a result of geothermal operations. The problem is odor. The California State standard to prevent odor from H_2S is 0.03 ppm, which is 42 $\mu g/m^3$. The odor threshold for ammonia is 46.8 ppm, which is about 35,000 $\mu g/m^3$. The odor of hydrogen sulfide has been detected at the Geysers. At Cerro Prieto, which lies in the southern part of the Salton Trough in Mexico, Axtmann[19] estimates the H_2S emissions to be 15 times higher than at the Geysers. In addition to the odor problem, H_2S is believed to be converted in the atmosphere to SO_2 and sulfate compounds.

5.4 OVERVIEW OF GEOTHERMAL DEVELOPMENT

The development of Imperial Valley's geothermal resources has been characterized by years of efforts thwarted by insufficient interest and funds, as well as underdeveloped technology. Early exploratory drilling recovered CO_2 and potash primarily as commercially usable by-products. Problems resulting from drilling highly saline brine made initial geothermal drilling

Table 5.4. Noncondensable gas and solid emissions at the Geysers geothermal plant.[a]

	Noncondensable gases[18]		Solids[18]
	kg/MW•hr	Percent[b]	kg/MW•yr
CO_2	25.93	81.9	
H_2S	1.80	5.7	
NH_3	1.54	4.8	
CH_4	1.54	4.8	
H_2	0.45	1.4	
N_2	0.42	1.3	
As			0.017
B			35.
Hg			0.001

[a]Noncondensable gases constitute 0.4% (dry weight) of the atmospheric emissions with steam constituting the remaining 99.6%.

[b]Percent of the noncondensable gas fraction.

sites either economically unfeasible or at best short-lived undertakings. It was finally the unproductive wildcat tests for oil and natural gas that fostered enough interest in site studies, equipment improvements, and drilling techniques to insure the support of the private, industrial, and governmental sectors necessary to fully explore the geothermal potential of the valley. Table 5.5 summarizes the significant drillings and studies that have taken place in the valley.[20] Current and on-going operations are shown in Table 5.6.

Table 5.5. Significant drillings and studies conducted in Imperial Valley.

Year	Location	Organization	Well depth and type of findings	Results
1927	Mullet Island (Salton Sea area)	Pioneer Development Company	449 m — Steam, carbon dioxide and hot water	Well abandoned; steam lacked sufficient pressure for power generation.
1934–1954	Mullet Island vicinity	——	150-200 m — Carbon dioxide and hot water	Approximately 60 wells recovered CO_2 from shallow sands containing hot water (as high as 60°C). A commercial dry ice plant that had operated at the site from 1932 to 1954 was shut down and well drilling discontinued when rising waters of the Salton Sea began to inundate the field.
1957	Mullet Island vicinity	——	1400 m — 600°F Brine	Wildcat test for oil and natural gas was unsuccessful.
1957–1958	Niland	Kent Imperial Corporation	1440 m — Hot water and steam 600°F	Sinclair #1 well produced steam intermittently for 4 months before the highly saline and corrosive brines encountered in the area forced a shut down when the well scaled up at the surface.
1961	Salton Sea area	Joseph I. O'Neill, Jr.	1441 m — Steam and high salinity water	Sportsman #1 well was a good steam producer, but had highly saline brine flows.

Table 5-5. (Continued)

Year	Location	Organization	Well depth and type of findings	Results
1962	Salton Sea area	Joseph I. O'Neill, Jr.	5232 ft — Steam and brine 207°C	Hypersaline brine caused scaling and corrosion problems.
1963	Brawley vicinity	Standard Oil Co. of California	4097 m — Hot water and steam	Oil exploration unsuccessful but prompted more extensive geothermal research in area.
1965		Imperial Thermal Products, Inc. (subsidiary of Morton International) and Earth Energy Company (subsidiary of Union Pure Oil Co.)	— Brine	Plants were primarily designed to recover potash from brine; however, a drastic drop in the price of this mineral and scaling problems made the projects economically unfeasible.
1968	Salton Sea area	University of California at Riverside (UCR) (supported by U.S. Bureau of Reclamation, National Science Foundation (NSF) and others)	—	Study located several KGRAs and other geophysical data. Also estimated that recoverable water in storage was in the magnitude of 1 billion acre-feet.

Table 5-5. (Continued)

Year	Location	Organization	Well depth and type of findings	Results
1968	Imperial Valley	UCR	—— Heat anomalies	Discovered four and possibly five new high heat flow areas, excluding the already known geothermal field in the Buttes area. The high-heat flow areas were named the North Brawley, Heber, Dunes, and Mesa. A moderate anomaly was discovered east of Brawley and designated the east Brawley anomaly.
1972	Salton Sea - Imperial Valley area	California Division of Oil and Gas (Funded by National Geodetic Survey, NSF and others)	—— Steam and hot water	12 wells were drilled in the Salton Trough, 3 in Salton Sea area, 3 on the Heber anomaly, 1 on the East Mesa anomaly, and 1 on the Dunes anomaly. A subsidence surveillance network in the Imperial Valley and adjacent lands was also established.
1973-1974	Imperial Valley-Salton Sea area	San Diego Gas & Electric Co. (SDG&E), Phillips Petroleum, Lawrence Livermore Laboratory (LLL), Chevron Oil Co., U.S. Bureau of Reclamation	—— Geothermal brines	12 geothermal wells were drilled in the Imperial Valley: 4 in the centra valley, 4 at East Mesa, 1 in the Salton Sea area, and 3 in the Heber area.

Table 5.6. Geothermal research and development projects in Imperial Valley.

Source funding	Type project	Performing organizations(s)	Principal investigator(s)	Research and development
National Science Foundation (NSF)	H_2S effects	University of California, Riverside (UCR)	C. Ray Thompson	Behavior of H_2S in the atmosphere and its effects on vegetation.
NSF	Computer simulation	Systems, Science and Software	John Pritchett and Larry Rice	A reservoir modeling study.
NSF	Geothermal metals	Battelle Northwest	David E. Robertson	An investigation of the nature and environmental aspects of heavy metals released during geothermal energy development.
NSF	Noise effects	St. Mary's College, Dept. of Biology, Moraga, Ca.	Phillip Leitner	The environmental effects of noise (on animals) from geothermal resource development.
NSF	Trace elements	University of Southern California, Environmental Engineering Program.	Kenneth Chen	Study of trace elements found in geothermal wastewaters.
NSF	Geological	UCR	Wilfred Elders	A geological study of the Salton Sea Anomaly.
NSF	Geothermal development planning		David E. Pierson et al	The Imperial County Geothermal Element Study.

Table 5-6. (Continued)

Source funding	Type project	Performing organization(s)	Principal investigator(s)	Research and development
NSF	Geological	Systems Control Inc., Palo Alto, CA.	E. John Finnemore	Subsidence study.
Energy Research and Development Agency (ERDA) in cooperation with industry, local, state and other federal agencies	Environmental effects	Lawrence Livermore Laboratory (LLL)	Lynn Anspaugh and Paul Phelps	An environmental baseline data and integrated assessment study.
ERDA	Geothermal development	LLL	Arthur L. (Roy) Austin	Studies on geothermal technology development. Most of the research program is based on the total flow concept and scale and corrosion control.
San Diego Gas & Electric, (SDG&E) Magma Power Co., and ERDA	Pilot plant	SDG&E and Magma Power Co.	James Nugent and Robert Lacey	A proposed 10-MW pilot plant operation in the Salton Sea anomaly. The primary interest is in the development of a binary cycle system for power generation.
ERDA and Southern California Edison	Pilot plant	Southern California Edison, Phillips Petroleum, and Southern Pacific Land Co.	J. Lynn Rasband, Craig Racine, and William Berge	A proposed 10-MW pilot plant operation in the Sinclair tract. The main goals are continuous and reliable production of geothermal brine, development of suitable reinjection systems, and controlling the problem of scaling and corrosion.

Table 5-6. (Continued)

Source funding	Type project	Performing organization(s)	Principal investigator(s)	Research and development
U.S. Bureau of Reclamation	Desalination	U.S. Bureau of Reclamation, ERDA, Bechtel and TRW	Manuel Lopez and M. K. Fulcher	A desalination demonstration project taking place in the East Mesa as part of continuing operations.
ERDA	Design Work	TRW Corporation	Robert Douglas and Joseph Kennedy	Hardware test facility in East Mesa area.
ERDA	Equipment study	Sperry-Sun	Warren McBee	Test of Sperry-Sun down-hole pump at Heber.
ERDA	Socioeconomic	Battelle Memorial Institute, Human Affairs Research Center	C. Richard Schuller and Roland Cole	A study of the legal institutional and political problems confronting geothermal development in California.
ERDA	Economics	Bechtel Corp.	Jerry W. Hankin	Conceptual design and capital cost estimates for two 50-MW plants.
ERDA and California Energy Commission	Regional planning project	Jet Propulsion Laboratory (JPL), Pasadena, Ca. and Stanford Research Institute (SRI), Palo Alto, Ca.	Richard Maullin and Charles Frederickson	An assessment of geothermal resources in California with consideration of the various implications of energy development.
U.S. Bureau of Reclamation	Reservoir study	Inter-Comp	Larry Rice	

Table 5-6. (Continued)

Source funding	Type project	Performing organization(s)	Principal investigator(s)	Research and development
EPA	Environmental effects	Environmental Protection Agency (EPA), Las Vegas	Don Gilmore	Assesses the environmental impact of extraction, conversion, and waste disposal of geothermal systems.
ERDA	Data base	Lawrence Berkeley Laboratory (LBL)	Sidney Phillips	Project seeks to establish a National Geothermal Information Resource (both library and computer based).
ERDA in cooperation with U.S. Bureau of Reclamation	Test facility	U.S. Bureau of Reclamation and LBL	M.K. Fulcher, Ken Mirk	Development of a geothermal test facility at the East Mesa Test Facility.
ERDA	Test facility	TRW, LBL	Russ Pierson, Ken Mirk	This is a continuation of test facility development at the East Mesa Test Facility.
ERDA and State (California) Energy Resource Conservation and Development Commission	Computer simulation	Jet Propulsion Laboratory (JPL) and Stanford Research Institute (SRI)	Dan Kerrick, Casey Mohl (JPL)	Operations research/system analysis planning for geothermal development.
ERDA	Socio-economic	Centaur Management Consultants	Isabel Reiff and Mike Franfel	Study of socioeconomic aspects of geothermal development.
U.S. Bureau of Reclamation	Desalination	Bechtel Corp.	Jerry N. Hankin, Leon Awerback, Thomas Lindemuth, and Emile Houle	Two experimantal desalination plants operating in the East Mesa are available to researchers studying the characteristics of geothermal fluids. Each unit is designed to produce 75 to 190 kl of distilled water per day.

Table 5-6. (Continued)

Source funding	Type project	Performing organization(s)	Principal investigator(s)	Research and development
Electric Power Research Institute (EPRI)	Feasibility study	Ben Holt, ProCon, Inc., and Geonomics, Inc. (Subcontractors)	Vasel Roberts, Phillip La Mori, Charles Best, George Wiegele, Tsvi Meidav, and Mae Meidav	A study of the effects and feasibility of developing geothermal resources in the Heber anomaly.
EPRI and SDG&E	Environmental effects	Envi Con, etc. (Subcontractors)	Vasel Roberts and Phillip La Mori	Baseline environmental study in the Heber area.
Republic Geothermal, Inc. and City of Burbank	Geothermal exploration	Republic Geothermal, Inc.	Robert Rex, Tim Evans, and Martindale Kile	Exploration program.
Magma Power, Inc.	Geothermal exploration and development	Magma Power, Inc.	Thomas Hindrichs	Continuing exploration activities as well as the drilling of two wells in the East Mesa anomaly area. Planning started on a 10-MW pilot plant
Union Oil Co.	Geothermal exploration	Union Oil Co. of California	Carel Otte and Anthony J. Chasteen	Exploration drilling in the Brawley and Heber anomalies.
Geothermal Energy Systems, Inc.	Equipment study	Energy Systems Inc., Newport Beach, Ca.	Ray Rodde	Project to develop a down-hole heat exchanger.

Table 5-6. (Continued)

Source funding	Type project	Performing organization(s)	Principal investigator(s)	Research and development
SDG&E (in relation to Palo Verde Sun Desert nuclear power plant).	Equipment study	SDG&E	James Nugent	Transmission corridor study that may have application to geothermal power transmission.
California Division of Oil and Gas, LLL, USGS and other	Subsidence	Imperial County Department of Public Works, U.S. Bureau of Reclamation, the National Geodetic Survey, and the Imperial Irrigation District	David Estes, Ben Lofgren, and Harold Ganow	An on-going program that monitors the subsidence survey network.
UCR	Seismo-logical networks	UCR	Shawn Biehler	Salton Sea area
USGS and Calif. Institute of Technology (CIT) with partial funding from LLL		USGS and CIT	Gary Fuis	Valley wide
ERDA/LLL		USGS	Neil Crow and Paul Kasameyer	Salton Sea area
U.S. Bureau of Reclamation		U.S. Bureau of Reclamation	Kim Mathias	East Mesa

Table 5-6. (Continued)

Source funding	Type project	Performing organization(s)	Principal investigator(s)	Research and development
USGS	Geology	USGS, Menlo Park, Ca.	L.J.P. Muffler and Ben Lofgren	Geologic research program.
Bob Bonds & Assoc.	Resource investigation	Bob Bonds & Assoc., Montgomery, Texas	H.R. Bond	Study designed to determine feasibility of mineral extraction from geothermal brines.
Morton-Norwich	Resource investigation	Imperial Thermal Products	Charles Yeater	Feasibility studies on mineral extraction from geothermal brines.
EPRI and State (California) Energy Commission	Equipment study	Ben Holt, Inc. (Subcontractors: Pro-con, Geonomics)	Ed Ghormley	Heat exchanger test at the Chevron site at Heber.
ERDA	Feasibility study	TRW and Holly Sugar	Russ Pierson	Study to determine how geothermal energy can be used in the Holly Sugar Plant.
ERDA	Feasibility study	Valley Nitrogen Products, West Tech Services	Bill Johnson	Research on direct heat utilization by Valley Nitrogen Products.

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Section 6
County Economic Characterization

Kendall Haven

6.1 COUNTY ECONOMIC COMPOSITION:

The economy of Imperial County has been dominated by agricultural activities since the early 1900's. The sectors currently active in the county economy are described in California County Business Patterns[1] collected annually by the U.S. Department of Commerce for employment for payroll, and more recently by Lofting[2] for sector dollar transactions in a county input/output (I/O) model. The County Business Patterns gives activities by Standard Industrial Codes (SIC's) but include only those activities covered by state employee compensation coverage. Thus, most agricultural activities, railroads, and governmental activities are not included. These are very significant omissions for Imperial County, since agricultural and governmental (federal, state, and local) activities are two of the largest sectors in the county for both payroll and employment. The principal value of the County Business Patterns data is in analyzing county labor force distributions, sector employment potentials, mean salary levels, etc.

The Lofting I/O model, showing dollar flows between economic business sectors, can be used to analyze the infrastructure of the county economy to predict overall changes in the economy resulting from changes in any one sector. The sector designations in this model do not correspond directly to the SIC's in County Business Patterns and, in general, direct comparison of data in the I/O model and County Business Patterns is not possible. Such direct comparison can only be made at the level of major economic divisions (manufacturing, wholesale, etc.). Finally, the I/O model does include government and agriculture, which is subdivided into eight subsectors (field crops, fruits and vegetables, beef cattle and livestock, etc.).

Neither the I/O model nor the complete County Business Pattern tables are reproduced in this report. Table 6.1 lists County Business Patterns payroll and employment data for Imperial County by SIC. Employment data collected by Lofting in support of his model development are given where significant discrepancies exist between his and the data from County Business Patterns. These discrepancies bordering on two different sectors are assigned under different sector headings. Additional discrepancies can develop as a result of the differing

Table 6.1. Imperial County sector employment and payroll for 1972.[1]

SIC number	Sector name	Employment[a]		Payroll	
		County Business Patterns[1]	Data, Lofting[2]	First quarter payroll 1972 — $K	Pay/ employee ratio
07	Agricultural services, forestry, fishing	681		1651	2.42
0700	Agricultural services and hunting	681		1651	2.42
0710	Miscellaneous agricultural services	488		1333	2.73
0720	Animal husbandry	176		310	1.76
10	Mining	16		15	0.94
15	Contract construction	620		1243	2.00
1500	General building construction	153		238	1.56
1600	Heavy construction	151		306	2.03
1700	Special trade	316		699	2.21
1710	Plumbing, heating, air conditioning	75		175	2.33
1730	Electrical	45		107	2.38
19	Manufacturing	1475	1508	2776	1.99
2000	Food and kindred	490		940	1.92
2040	Grain mills	165	189	284	1.72
2042	Prepared feed for animals	165		283	1.72
2060	Sugar	139		280	2.01
2063	Beet sugar	139		280	2.01
2300	Apparel, other textiles	34		42	1.24
2400	Lumber and wood	136		228	1.68
2700	Printing and publishing	150		216	1.44
2710	Newspapers	122		175	1.43
2800	Chemical and allied manufacturing	108	130	374	2.88

[a]Employment in subcategories will not total to one-digit SIC because only certain subcategories (two-, three-, and four-digit SIC) are listed.

Table 6.1. (Continued)

SIC number	Sector name	Employment[a]		Payroll	
		County Business Patterns[1]	Data, Lofting[2]	First quarter payroll 1972 — $K	Pay/ employee ratio
2870	Agricultural chemicals	103	130	296	2.87
3200	Stone, clay and glass manufacturing	451		1041	2.31
3270	Concrete, plaster	451		1041	2.31
3273	Ready mix	139		320	2.30
3275	Gypsum products	273		630	2.31
3500	Machinery except electrical	58		123	2.12
3900	Miscellaneous manufacturing	48		89	1.85
40	Transportation and public utilities	2042		1733	1.96
4100	Local and interurban transportation	117		211	1.80
4200	Trucking and warehousing	351		697	1.99
4210	Trucking	294		600	2.04
4211	Trucking without storage	289		589	2.04
4700	Transportation services	20		35	1.75
4800	Communications	283		531	1.88
4810	Telephone	218		409	1.88
4900	Electricity, gas, and sanitary utilities	1271		3519	2.77
4910	Electrical utilities	100		297	2.97
4950	Sanitary services	32		72	2.25
4970	Irrigation systems	1139		1563	1.37
50	Wholesale	1422		2469	1.74
5040	Groceries and related	558		1026	1.84

Table 6.1. (Continued)

SIC number	Sector name	Employment[a]		Payroll	
		County Business Patterns[1]	Data, Lofting[2]	First quarter payroll 1972 — $K	Pay/ employee ratio
5048	Fresh fruit and vegetables	464		828	1.78
5050	Farm products — raw materials	240		212	0.88
5052	Cotton	74		65	0.88
5090	Miscellaneous food and kindred manufacturing	383		782	2.04
5092	Petroleum products	61		101	1.66
5099	Miscellaneous manufacturing	135		285	2.11
52	Retail trade	4586	4611	5690	1.25
5200	Building materials and farm equipment	313	356	531	1.70
5250	Hardware and farm equipment	210		331	1.58
5251	Hardware stores	106		167	1.58
5252	Farm equipment dealers	104		163	1.57
5300	General retail	600		659	1.10
5310	Department stores	236		289	1.20
5330	Variety stores	172		137	0.80
5390	Miscellaneous general retail	157		162	1.03
5400	Food and kindred	686		1124	1.64
5410	Grocery stores	605		1011	1.67
5500	Auto and auto services	985		1458	1.48
5510	New and used car dealers	419		772	1.84
5530	Tires, batteries, and accessories	164		278	1.70
5540	Gas station services	372		380	1.02

Table 6.1. (Continued)

SIC number	Sector name	Employment[a]		Payroll	
		County Business Patterns[1]	Data, Lofting[2]	First quarter payroll 1972 — $K	Pay/ employee ratio
5600	Apparel and accessories	432		395	0.91
5620	Women's ready-to-wear	157		126	0.80
5650	Family clothes	201		181	0.90
5700	Furniture	125		177	1.42
5800	Eating and drinking places	910		637	0.70
5900	Miscellaneous retail	517		683	1.23
5910	Drug stores	197		306	1.55
5920	Liquor stores	68		60	0.88
5930	Antique stores	32		37	1.16
5960	Farm and garden	84		141	1.68
5990	Miscellaneous retail	53		42	0.79
60	Finance, insurance, real estate	624		1055	1.69
6000	Banking	310		594	1.92
6020	Commercial banking	310		594	1.92
6100	Credit agencies	84		146	1.74
6140	Personal credit	52		90	1.73
6400	Insurance	58		83	1.00
6500	Real estate	87		78	0.90
6510	Real estate operator and lessor	71		66	0.93
70	Services	2050		2462	1.20
7000	Hotel and other lodging	244		257	0.75
7010	Hotel, motel	326		242	0.74
7200	Personal services	280		309	1.10
7210	Laundries	143		156	1.09
7230	Beauty shops	98		90	0.92

Table 6.1. (Concluded)

SIC number	Sector name	Employment[a]		Payroll	
		County Business Patterns[1]	Data, Lofting[2]	First quarter payroll 1972 — $K	Pay/ employee ratio
7300	Miscellaneous business services	184		239	1.30
7390	Miscellaneous business services	113		163	1.44
7500	Auto repair and services	126		157	1.25
7530	Auto repair	104		143	1.38
7538	General auto repair	53		73	1.38
7600	Miscellaneous auto repair	80		120	1.50
7690	Miscellaneous auto repair shops	41		65	1.59
7900	Amusement and recreation	89		87	0.98
8000	Medical and other health	359		560	1.56
8010	Offices of doctors	204		367	1.80
8020	Office of dentists	54		58	1.07
8100	Legal services	52		87	1.62
8600	Nonprofit organizations	261		267	1.02
8640	Civic and social groups	62		34	0.55
8660	Religious services	34		18	0.53
8690	N.E.C. services	103		141	1.37
8900	Miscellaneous services	107		216	2.02
8930	Accounts auditing	51		102	2.00
99	Unclassified	119		115	0.97
100	All agriculture	6840		4537	0.71
Total		13635[b]		19210	1.55

[b]Does not include government, railroads, and some agriculture.

methodologies used for filling in information omitted from the data by the Department of Commerce because of federal disclosure laws. The data in Table 6.1 serve as a basic description of economic activities in Imperial County and their relative magnitude and importance; some analysis of this information is provided in section 6.5 of this report. A more detailed analysis of agriculture is given in sections 6.2 and 6.3 which deal with agriculture and county employment, respectively.

Economic Sector Description

The data in Table 6.1 provide some interesting insights into the Imperial County economy. First, manufacturing employment is very low in Imperial County, and the county is slightly below state average for construction. These are two relatively high paying economic sectors as indicated by their respective pay/employee ratios. Agricultural services (SIC-07) has the highest pay/employee ratio of the major economic divisions, while the highest sector ratio is in chemical manufacturing (SIC-2800). Imperial County is one of the state centers for SIC-07 activity and is near average in sector 2800. Relatively high paying local activities increase the circulation of monies within the local economy by increasing household sector purchases. Lower paying jobs tend to result in a concentration of household expenditures in a narrower range of basic goods, while higher pay results in a wider diversification of household spending and, as a result, increased employment in more diverse wholesale, retail, and service sectors.

Manufacturing activity is very important to a local economy because manufactured products tend to be exported outside the local area. These export activities (basic sectors) such as agricultural and manufacturing activities bring new money into the local economy. Nonbasic activities (wholesale, retail, services, etc.) circulate and redistribute money within the local economy but tend not to generate new money. The data in Table 6.1 illustrates that basic sectors tend to have higher pay/employee ratios than nonbasic sectors. The principal exception is agriculture, which traditionally has paid low wages.

Table 6.2 lists the major sectoral omissions in the 1972 employment data that are now part of Imperial County's economy. Several of these industries (1300, 1381, 1382) are associated with geothermal activity. Since 1972, several new industrial activities have located

Table 6.2. Major sectors absent from the Imperial County employment data in 1972.

SIC number	Industry title
1300	Oil and gas extraction
1381	Drilling wells
1382	Exploration services
2010	Meat products manufacturing
2030	Canned cured and frozen food manufacturing
2200	Textile mill products
2600	Paper and allied products manufacturing
3400	Fabricated metal manufacturing
3520	Farm machinery manufacturing
3530	Construction machinery manufacturing
8060	Hospitals
8200	Education services

in Imperial Valley and are listed in Table 6.3. These listings reduce Table 6.2 omissions by several sectors. While some of the major sectors not found in the Imperial County economy can be significant paths for the export of dollars out of a local economy (i.e., SIC's 2010, 2030, 2600 and 3520), the list is small for a county with a population of approximately 83,000. Further analysis of the economic position of Imperial County is included in section 6.4 of this report.

Multiplier Effects

A sector multiplier measures the total dollar amount of economic activity that will be generated in a local economy by a $1 increase in external demand for a product of that local economy. If a demand is generated outside of the County economy (as represented by an input/output model) for a product of that economy (agricultural products, geothermal energy, Salton Sea recreation, etc.) then the I/O model tells us that the increase in activity in that one sector will also cause increased activity in other sectors. A multiplier measures this total generated activity. Lofting's I/O model has been used to generate various multipliers for each sector in the Imperial County economy.

Table 6.3. New industrial activities in Imperial County (1972-1974).[a]

	Company	Estimated jobs	Location
1.	Anthony Williams Inc. Clothing manufacturing	60	El Centro
2.	A. & J. Manufacturing Company Golf equipment manufacturing	40	El Centro
3.	Chem Fab Corporation Chemical milling processing	30	Imperial
4.	3 J Manufacturing Company Clothing manufacturing	100	Calexico
5.	Ameron Steel Steel products (Under construction)	35	Imperial
6.	El Centro Garment Manufacturing Inc.	150	El Centro
7.	Kona Kai (Under construction)	100	Calexico
8.	Suzy Manufacturing Company (Under construction) Curtain manufacturing	150	Calexico
9.	Imperial Yarn & Needle Manufacturing mops	65	Calexico
10.	Earley's Textiles Center Inc.	35	Holtville
11.	Dune Buggy Enterprises Assemblying dune buggies	8	Brawley
12.	R. R. Ornamental Design Wrought iron — fabricators	3	Brawley

[a]From Imperial County Ultimate Land Use Plan, p. 17.[3]

(See Tables 6.4a, 6.4b, 6.4c, and 6.4d.)

All multipliers in Tables 6.4a-d are for both direct and indirect (total) effects of the increase in sector unit demand. In explanation of the column headings of Table 6.4a, an output multiplier represents the total number of dollars generated in the local economy by a dollar increase in sector final demand, employment multiplier is the change in employment per million dollars of sector output generated by a unit increase in sector final demand, and value added multipliers measure total value added throughout the local economy as a result of a unit increase

Table 6.4a. Imperial County economy multipliers.[2]

Column[a] number	Sector multipliers Sector name	Output multiplier	Employment multiplier	Value added multiplier
1	Dairies	1.51225	1.2252	1.5494
2	Poultry and eggs	1.79968	1.5544	2.9848
3	Meat animals and misc. livestock	2.00638	2.1831	2.3905
4	Cotton	1.36598	1.2612	1.6232
5	Food feed grains and grass seeds	1.36380	4.4723	1.3719
6	Fruits and tree nuts	1.23597	1.1968	1.2395
7	Vegetables, sugar beets, and misc. crops	1.25002	1.8597	1.2414
8	Greenhouse and nursery products	1.16118	1.2019	1.1171
9	Agriculture, forestry, fishery service	1.01886	1.0091	1.0160
10	Stone and clay mining and quarrying	1.19785	1.3740	1.1969
11	Chemical and fertilizer mineral mining	1.08607	1.2142	1.0668
12	New construction, resident, (nonfarm)	1.30115	1.4723	1.6033
13	New construction, nonresident	1.27763	1.4557	1.5539
14	New construction, public utilities	1.19910	1.2693	1.3935
15	New construction, highways	1.31991	1.4868	1.5027
16	New construction, all other	1.21795	1.5674	1.3365
17	Maintenance and repair construction, residential	1.19176	1.1495	1.2665
18	Maintenance and repair construction, all other	1.14039	1.1996	1.1531
19	Meat products	2.27025	3.1966	3.9571
20	Flour and other grain mill products	1.46946	1.8714	1.7688
21	Prepared feeds for animals and fowls	1.63371	1.9161	2.9878

[a]Column numbers correspond to those used by Lofting.[2]

Table 6.4a. (Continued)

Column number	Sector name	Sector multipliers: Output multiplier	Employment multiplier	Value added multiplier
22	Sugar	2.26589	3.0430	2.9758
23	Bottled and canned soft drinks	1.21720	1.1670	1.2419
24	Animal and marine fats and oils	1.44362	1.6675	1.4747
25	Manufactured ice	1.29195	1.1781	1.3116
26	Apparel made from purchased materials	1.07409	1.0644	1.1216
27	Prefabricated wood structures	1.14459	1.1434	1.2797
28	Wooden containers	1.09982	1.1279	1.1745
29	Newspapers	1.12083	1.0620	1.1232
30	Miscellaneous publishing	1.14008	1.1322	1.1272
31	Commercial printing	1.09504	1.0963	1.1115
32	Fertilizers	1.17600	1.3927	1.3340
33	Agricultural chemicals	1.06508	1.1684	1.1200
34	Miscellaneous plastics products	1.09695	1.1163	1.1423
35	Concrete products	1.19286	1.1835	1.2003
36	Ready-mixed concrete	1.22910	1.3702	1.3866
37	Gypsum products	1.13692	1.1886	1.1481
38	Cut stone and stone products	1.17827	1.1751	1.1640
39	Nonmetallic mineral products	1.28278	1.2466	1.3412
40	Sheet metalwork	1.09175	1.1090	1.1560
41	Farm machinery	1.10598	1.1823	1.1590
42	Machine shop products	1.12466	1.1074	1.1186
43	Sporting and athletic goods	1.16711	1.1805	1.2199
44	Signs and advertising displays	1.13824	1.1503	1.1722
45	Railroads	1.08264	1.0900	1.0717

Table 6.4a. (Continued)

Column number	Sector name	Sector multipliers: Output multiplier	Employment multiplier	Value added multiplier
46	Local, suburban, interurban transportation	1.11682	1.0986	1.1164
47	Motor freight transportation and warehousing	1.24710	1.2462	1.2565
48	Transportation services	1.05974	1.0363	1.0456
49	Communication except radio and TV	1.04581	1.0404	1.0297
50	Radio and television broadcasting	1.46857	1.5086	1.3863
51	Electric companies and systems	1.16884	1.6397	1.1734
52	Water and sanitary services	1.19601	1.4537	1.5945
53	Wholesale trade	1.13624	1.1103	1.1038
54	Retail trade — general merchandise	1.08163	1.0395	1.0825
55	Banking	1.11077	1.1242	1.0876
56	Credit agencies other than banks	1.60238	1.3535	0.0000
57	Insurance agents, brokers, and service	1.23351	1.2595	1.2189
58	Owner occupied dwellings	1.05663	0.0000	1.0405
59	Real estate	1.18286	1.5230	1.1395
60	Hotels, rooming houses, camps, etc	1.17622	1.0347	1.1289
61	Personal services	1.07235	1.0420	1.0527
62	Barber and beauty shops	1.00143	1.0004	1.0012
63	Miscellaneous business services	1.15393	1.1208	1.1434
64	Miscellaneous services	1.21328	1.1743	1.1622
65	Car repair, services, and garages	1.26466	1.4779	1.6653
66	Motion pictures	1.80112	1.9235	1.8605
67	Amusement and recreation services	1.20222	1.0909	1.1581

Table 6.4a. (Continued)

Column number	Sector name	Sector multipliers: Output multiplier	Employment multiplier	Value added multiplier
68	Doctors and dentists	1.19603	1.2700	1.1803
69	Health and allied services	1.25455	1.1572	1.2729
70	Educational services	1.23307	1.1139	1.2685
71	Nonprofit organization	1.27940	1.1100	1.2874
72	Federal government enterprises	1.17700	1.1357	1.1255
73	State and local government enterprises	1.14652	1.1016	1.1242
74	Business travel, entertainment, gifts	1.24467	0.0000	0.0000
75	Office supplies	1.90715	0.0000	0.0000
76	Scrap, used, secondhand goods	1.05418	0.0000	0.0000

in any single sector. Sectors with high multiplier values generate the greatest benefit for the economy as a whole when their output is increased. Thus from the ranking in Table 6.4b, it is seen that increases in feed lot operations and meat production generate considerable total activity, while an increase in barber shops will have no real effect on the economy. Because the Imperial County economy has traditionally been centered around agricultural products, those sectors associated with agriculture tend to have a greater effect upon other sectors in the economy and, therefore, tend to have higher multipliers.

6.2 AGRICULTURAL SECTOR ANALYSIS

The value and amount of planted acreage of the major Imperial Valley crops are well-documented by the county and the state. Data from recent years are summarized in Table 6.5. Recent increases in total planted acreage can be attributed primarily to an increase in double planting on many fields. The distribution and characteristics of crops within the valley are described in Section 4 (Biological Resources) of this report, as well

Table 6.4b. Ranked sector multipliers: output multiplier.

Column number	Sector name	Output multiplier	Output multiplier rank
19	Meat products	2.2702498	1
22	Sugar	2.2658885	2
3	Meat animals and misc. livestock	2.0063831	3
66	Motion pictures	1.8011162	4
2	Poultry and eggs	1.7996829	5
21	Prepared feeds for animals and fowls	1.6337148	6
56	Credit agencies other than banks	1.6023821	7
1	Dairies	1.5122523	8
20	Flour and other grain mill products	1.4694599	9
50	Radio and television broadcasting	1.4685672	10
24	Animal and marine fats and oils	1.4436233	11
4	Cotton	1.3659842	12
5	Food feed grains and grass seeds	1.3638000	13
15	New construction, highways	1.3199098	14
12	New construction, resident, (nonfarm)	1.3011469	15
25	Manufactured ice	1.2919542	16
39	Nonmetallic mineral products, nec	1.2827828	17
71	Nonprofit organization	1.2794011	18
13	New construction, nonresident	1.2776295	19
65	Car repair, services, and garages	1.2646639	20
69	Health and allied services, nec.	1.2545470	21
7	Vegetables, sugar beets, and misc. crops	1.2500204	22
47	Motor freight transportation and warehousing	1.2471033	23
74	Business travel, entertainment, gifts	1.2446683	24
6	Fruits and tree nuts	1.2359728	25
57	Insurance agents, brokers, and service	1.2335088	26
70	Educational services	1.2330731	27
36	Ready-mixed concrete	1.2291017	28
16	New construction, all other	1.2179537	29

Table 6.4b. (Continued)

Column number	Sector name	Output multiplier	Output multiplier rank
23	Bottled and canned soft drinks	1.2172030	30
64	Miscellaneous services	1.2132768	31
67	Amusement and recreation services	1.2022155	32
14	New construction, public utilities	1.1991023	33
10	Stone and clay mining and quarrying	1.1978533	34
68	Doctors and dentists	1.1960322	35
52	Water and sanitary services	1.1960103	36
35	Concrete products	1.1928626	37
17	Maintenance and repair construction, residential	1.1917602	38
59	Real estate	1.1828574	39
38	Cut stone and stone products	1.1782667	40
72	Federal government enterprises	1.1770037	41
60	Hotels, rooming houses, camps, etc	1.1762201	42
32	Fertilizers	1.1760041	43
51	Electric companies and systems	1.1688362	44
43	Sporting and athletic goods	1.1671086	45
8	Greenhouse and nursery products	1.1611817	46
63	Miscellaneous business services	1.1539346	47
73	State and local government enterprises	1.1465184	48
27	Prefabricated wood structures	1.1445854	49
18	Maintenance and repair construction, all other	1.1403895	50
30	Miscellaneous publishing	1.1400810	51
44	Signs and advertising displays	1.1382421	52
37	Gypsum products	1.1369190	53
53	Wholesale trade	1.1362421	54
42	Machine shop products	1.1246599	55
29	Newspapers	1.1208275	56
46	Local, suburban, interurban trans.	1.1168203	57

Table 6.4b. (Continued)

Column number	Sector name	Output multiplier	Output multiplier rank
55	Banking	1.1107723	58
41	Farm machinery	1.1059827	59
28	Wooden containers	1.0998196	60
75	Office supplies	1.0971536	61
34	Miscellaneous plastics products	1.0969475	62
31	Commercial printing	1.0950372	63
40	Sheet metalwork	1.0917474	64
11	Chemical and fertilizer mineral mining	1.0860722	65
45	Railroads	1.0826401	66
54	Retail trade — general merchandise	1.0816292	67
26	Apparel made from purchased materials	1.0740925	68
61	Personal services	1.0723509	69
33	Agricultural chemicals	1.0650765	70
48	Transportation services	1.0597393	71
58	Owner occupied dwellings	1.0566330	72
76	Scrap, used, secondhand goods	1.0541842	73
49	Communication except radio and TV	1.0458066	74
9	Agric., forestry, and fishery services	1.0188616	75
62	Barber and beauty shops	1.0014331	76

as data on temporal cycling of the planting, growing, and harvesting seasons of most major crops.

Long-term trends in the agricultural cropping patterns are very difficult to predict and result from a series of external economic, natural, and social factors, including national market demands and preferences, weather patterns, international trade, existing cropping patterns, etc. There is a significant trend toward mechanization for many crops. This trend is expected to continue as labor prices, currently above $2.50 per hour throughout the Valley,† climb above the capital

†The teamster union contract requires a minimum of $2.95 for preharvest and $3.03 for harvest period.[10]

Table 6.4c. Ranked sector multipliers: employment multiplier.

Column number	Sector name	Employment multiplier	Employment multiplier rank
5	Food feed grains and grass seeds	4.47228	1
19	Meat products	3.19663	2
22	Sugar	3.04300	3
3	Meat animals and misc. livestock	2.18310	4
66	Motion pictures	1.92354	5
21	Prepared feeds for animals and fowls	1.91608	6
20	Flour and other grain mill products	1.87142	7
7	Vegetables, sugar beets, and misc. crops	1.85970	8
24	Animal and marine fats and oils	1.66747	9
51	Electric companies and systems	1.63975	10
16	New construction, all other	1.56739	11
2	Poultry and eggs	1.55443	12
59	Real estate	1.52296	13
50	Radio and television broadcasting	1.50858	14
15	New construction, highways	1.48682	15
65	Car repair, services, and garages	1.47791	16
12	New construction, resident, (nonfarm)	1.47227	17
13	New construction, nonresident	1.45575	18
52	Water and sanitary services	1.45371	19
32	Fertilizers	1.39274	20
10	Stone and clay mining and quarrying	1.37400	21
36	Ready-mixed concrete	1.37019	22
56	Credit agencies other than banks	1.35345	23
68	Doctors and dentists	1.27003	24
14	New construction, public utilities	1.26925	25
4	Cotton	1.26120	26
57	Insurance agents, brokers, and service	1.25949	27
39	Nonmetallic mineral products	1.24664	28
47	Motor freight transp. and warehousing	1.24620	29

Table 6.4c (Continued)

Column number	Sector name	Employment multiplier	Employment multiplier rank
1	Dairies	1.22517	30
11	Chemical and fertilizer mineral mining	1.21419	31
8	Greenhouse and nursery products	1.20193	32
18	Maintenance and repair construction, all other	1.19957	33
6	Fruits and tree nuts	1.19681	34
37	Gypsum products	1.18857	35
35	Concrete products	1.18348	36
41	Farm machinery	1.18231	37
43	Sporting and athletic goods	1.18052	38
25	Manufactured ice	1.17815	39
38	Cut stone and stone products	1.17508	40
64	Miscellaneous services	1.17430	41
33	Agricultural chemicals	1.16845	42
23	Bottled and canned soft drinks	1.16700	43
69	Health and allied services	1.15717	44
44	Signs and advertising displays	1.15033	45
17	Maintenance and repair construction, residential	1.14945	46
27	Prefabricated wood structures	1.14335	47
72	Federal government enterprises	1.13570	48
30	Miscellaneous publishing	1.13219	49
28	Wooden containers	1.12765	50
55	Banking	1.12420	51
63	Miscellaneous business services	1.12076	52
34	Miscellaneous plastics products	1.11626	53
70	Educational services	1.11393	54
53	Wholesale trade	1.11033	55
71	Nonprofit organization	1.11005	56

Table 6.4c (Continued)

Column number	Sector name	Employment multiplier	Employment multiplier rank
40	Sheet metalwork	1.10900	57
42	Machine shop products	1.10739	58
73	State and local government enterprises	1.10158	59
46	Local, surburban, interurban transportation	1.09860	60
31	Commercial printing	1.09625	61
67	Amusement and recreation services	1.09090	62
45	Railroads	1.09000	63
26	Apparel made from purchased materials	1.06439	64
29	Newspapers	1.06203	65
61	Personal services	1.04205	66
49	Communication except radio and TV	1.04038	67
54	Retail trade — general merchandise	1.03949	68
48	Transportation services	1.03633	69
60	Hotels, rooming houses, camps, etc	1.03473	70
9	Agricultural, forestry, and fishery services	1.00907	71
62	Barber and beauty shops	1.00043	72
58	Owner occupied dwellings	0.00000	73
74	Business travel, entertainment, gifts	0.00000	74
75	Office supplies	0.00000	75
76	Scrap, used, secondhand goods	0.00000	76

and operational costs of mechanized systems. An important factor in either shifts to mechanization or shifts to alternate crops is the cost of production for that crop. These costs are compared in Table 6.6 for selected crops.

The data in Tables 6.5 and 6.6 reveal a considerable amount of information about Imperial Valley agriculturial economics. As seen in Table 6.5, field crops with a total value of $284,242,000 became the first crop group to break

Table 6.4d. Ranked sector multipliers: value added multiplier.

Column number	Sector name	Value added multiplier	Value added multiplier rank
19	Meat products	3.95713	1
21	Prepared feeds for animals and fowls	2.98783	2
2	Poultry and eggs	2.98483	3
22	Sugar	2.97584	4
3	Meat animals and misc. livestock	2.39046	5
66	Motion pictures	1.86049	6
20	Flour and other grain mill products	1.76881	7
65	Car repair, services, and garages	1.66532	8
4	Cotton	1.62320	9
12	New construction, residential, (nonfarm	1.60329	10
52	Water and sanitary services	1.59451	11
13	New construction, nonresidential	1.55386	12
1	Dairies	1.54944	13
15	New construction, highways	1.50274	14
24	Animal and marine fats and oils	1.47469	15
14	New construction, public utilities	1.39351	16
36	Ready-mixed concrete	1.38664	17
50	Radio and television broadcasting	1.38631	18
5	Food feed grains and grass seeds	1.37191	19
39	Nonmetallic mineral products	1.34116	20
16	New construction, all other	1.33652	21
32	Fertilizers	1.33399	22
25	Manufactured ice	1.31159	23
71	Nonprofit organization	1.28739	24
27	Prefabricated wood structures	1.27968	25
69	Health and allied services	1.27285	26
70	Educational services	1.26851	27
17	Maintenance repair and construction, residential	1.26654	28

Table 6.4d. (Continued)

Column number	Sector name	Value added multiplier	Value added multiplier rank
47	Motor freight transportation and warehousing	1.25653	29
23	Bottled and canned soft drinks	1.24185	30
7	Vegetables, sugar beets, and misc. crops	1.24137	31
6	Fruits and tree nuts	1.23953	32
43	Sporting and athletic goods	1.21990	33
57	Insurance agents, brokers, and service	1.21895	34
35	Concrete products	1.20026	35
10	Stone and clay mining and quarrying	1.19689	36
68	Doctors and dentists	1.18026	37
28	Wooden containers	1.17446	38
51	Electric companies and systems	1.17335	39
44	Signs and advertising displays	1.17225	40
38	Cut stone and stone products	1.16395	41
64	Miscellaneous services	1.16218	42
41	Farm machinery	1.15904	43
67	Amusement and recreation services	1.15809	44
40	Sheet metalwork	1.15599	45
18	Maintenance and repair construction, all other	1.15313	46
37	Gypsum products	1.14805	47
63	Miscellaneous business services	1.14338	48
34	Miscellaneous plastics products	1.14229	49
59	Real estate	1.13947	50
60	Hotels, rooming houses, camps, etc	1.12889	51
30	Miscellaneous publishing	1.12721	52
72	Federal government enterprises	1.12549	53
73	State and local government enterprises	1.12421	54
29	Newspapers	1.12321	55

Table 6.4d. (Concluded)

Column number	Sector name	Value added multiplier	Value added multiplier rank
26	Apparel made from purchased materials	1.12161	56
33	Agricultural chemicals	1.12003	57
42	Machine shop products	1.11855	58
8	Greenhouse and nursery products	1.11706	59
46	Local, suburban, interurban transportation	1.11638	60
31	Commercial printing	1.11152	61
53	Wholesale trade	1.10384	62
55	Banking	1.08757	63
45	Railroads	1.07165	64
11	Chemical and fertilizer mineral mining	1.06681	65
54	Retail trade — general merchandise	1.06248	66
61	Personal services	1.05273	67
48	Transportation services	1.04565	68
58	Owner occupied dwellings	1.04054	69
49	Communication except radio and TV	1.02971	70
9	Agriculture, forestry, and fishery services	1.01603	71
62	Barber and beauty shops	1.00118	72
56	Credit agencies other than banks	0.00000	73
74	Business travel, entertainment, gifts	0.00000	74
75	Office supplies	0.00000	75
76	Scrap, used, secondhand goods	0.00000	76

Table 6.5. Acreage and value of major Imperial Valley agriculture for selected years.

Crop	1968[4,5]		1969[4,5,6]		1973[7,8]		
	Acreage	Value	Acreage	Value	Acreage	Value	Acrea
Field crops		$92,220,000		$90,490,000	473,422	$176,311,000	475,6
Alfalfa	136,000		140,000	27,608,000	124,567	53,424,000	125,6
Alfalfa seed	15,000	1,512,000	7,300	648,000	1,660		2,3
Alicia grass					2,722		2,7
Barley	99,000		74,000	7,696,000	17,433	2,520,000	5,3
Bermuda grass					1,968		2,4
Bermuda grass (seed)					964		9
Cotton	38,190		44,000	17,499,000	36,857	30,160,000	78,8
Flax	2,000		1,800	246,000	80		
Oats					1,245		1,0
Rape					—		
Rye grass					27,456	3,770,000	18,8
Rye grass (seed)	620	13,000	80	2,600	509		2
Safflower	450		—		16		—
Sesbania					—		—
Sesbania (seed)	230	17,000	225	27,400	79		—
Sorghum grain	75,000		60,000	7,350,000	39,389	8,280,000	31,6
Sorghum silage	1,000		2,000	220,000	1,032	138,000	4
Sudan grass					13,224		14,4
Sugar beets	59,200		76,000	22,876,000	69,812	31,936,000	69,1
Wheat	1,000		10,000	1,300,000	94,407	26,000,000	101,4
Pasture (general)	240,000		243,000	3,062,000	195,000	4,086,000	192,0

Table 6.5. (Continued)

Crop	1968 Acreage	1968 Value	1969 Acreage	1969 Value	1973 Acreage	1973 Value	Acre
Vegetable crops	64,170	$66,231,000	64,625	$66,522,000	74,870	$119,102,000	84,
Asparagus	2,200	1,963,000	2,400	2,523,000	4,500	5,832,000	4,
Cabbage	2,710	1,723,000	1,300	782,000	470	619,000	1,
Carrots	4,900	5,145,000	4,200	4,150,000	4,500	7,092,000	5,
Cucumbers	380	560,000	390	277,000	520	527,000	
Lettuce	41,500	34,109,000	44,000	38,683,000	42,000	73,200,000	49,
Melons (other)	930	1,136,000	720	1,100,000	760	1,515,000	
Onions	1,700	2,617,000	2,300	1,495,000	1,500	6,304,000	1,
Onions (dehydrated)	1,070	444,000	1,240	560,000	1,680	740,000	3,
Squash	750	622,000	340	320,000	940	749,000	
Tomatoes	1,940	2,943,000	2,200	3,414,000	2,000	4,388,000	3,
Tomatoes (cannery)	280	147,000	–	–	–		-
Watermelons	4,410	1,588,000	4,100	1,613,000	4,000	2,935,000	2,
Mixed vegetables	1,400	1,365,000	1,435	1,605,000	2,500	2,697,000	2,
Cantaloupes	–	–	–	–	9,500	12,504,000	8,
Garlic					–	–	

Table 6.5. (Continued)

Crop	1968 Acreage	1968 Value	1969 Acreage	1969 Value	1973 Acreage	1973 Value	Ac
Fruits and nuts	1,680	$785,000	2,030	$988,000	2,916	$2,235,000	
Dates	70	91,000	35	119,000	140	212,000	
Grapefruit	400	266,000	300	156,000	400	168,000	
Lemons	130	39,000	230	230,000	620	654,000	
Oranges (Valencia)	750	251,000	750	311,000	920	406,000	
Tangerines	330	123,000	400	161,000	736	486,000	
Mixed fruit		15,000		11,000	100	18,000	
Citrus by-product						291,000	
Apiary		$273,500		$338,000		$1,478,000	
Honey	36,000	106,000	31,000	164,000	39,000	1,196,000	4:
Wax	36,000	10,500	31,000	15,000	39,000	32,000	4:
Pollination	32,000	157,000	32,700	159,000	29,000	250,000	2:

Crop	1968 Head	1968 Value	1969 Head	1969 Value	1973 Head	1973 Value	He
Livestock		$72,892,000		$88,393,000		$190,644,000	
Cattle	560,000	68,264,000	578,000	84,623,000	798,000	186,461,000	72(
Sheep	160,000	2,362,000	100,000	1,641,000	160,000	2,873,000	16(
Wool	167,000	366,000	110,000	219,000	180,000	689,000	162
Milk		1,799,000		1,808,000		599,000	
Miscellaneous livestock						22,000	
Hogs	2,000	84,000	1,500	72,000			
Chicken (hens)	2,500	600	2,500	1,000			
Eggs		26,300		29,000			

Table 6.6. Approximate (1975 dollars) costs of major Imperial Valley crops per acre per

Crop	Fixed costs	Land preparation	Planting (Crop establishment)	Cultural costs	Har
Alfalfa	$ 71.74[a]	$ 31.30[a]	$18.17[a]	$ 32.23[a]	$ 4:
Cereal crops	130.30	50.50	17.00	34.55	3:
Cotton	188.65	65.75	26.95	209.65	10(
Rye grass	107.29	38.50	11.70	51.75	(
Sorghum (grain)	131.72	55.00	11.90	40.25	3:
Sugar beets	200.29	103.65	27.50	207.45	9(
Asparagus	236.89 - 278.26[b]	120.10[a]	88.25	365.75 - 243.00[c]	40(1,35(
Cabbage	237.05	99.38	35.50	440.50	1,00(
Carrots	215.49	131.88	19.50	244.38	16:
Lettuce	236.72	99.38	39.50	433.75	85(
Tomatoes	244.56	109.30	26.25	502.45	1,65:

[a] One-third of total costs for 3-yr stand of alfalfa.

[b] First year rate only.

[c] Last figures for established field.

the lead status of livestock as the most valuable activity in 1974. Over the 1969 to 1974 period, field crops, especially alfalfa, have been increasing in value and in planted acreage much faster than any other agricultural group and, as noted, much faster than livestock. In fact, of the five major groups listed in Table 6.5 field crops is the only one that did not decline in value in 1974 even though planted acreage for field crops rose only 0.5%, while vegetable crops rose 15% in planted acreage and fruits and nuts rose 10%. Over the 1972 to 1974 period there has been a steady decline in the number of cattle raised in Imperial Valley and, associated with this decline, a steady decline in the unit value of cattle after feed lot fattening. These trends seem to indicate that farmers are shifting toward field crops over other uses. However, when crop value per acre is calculated from Table 6.5, we see that field crops and fruits and nuts yielded identical gross returns of $662.50 per acre, while vegetable crops yielded almost twice that amount ($1,222.80 per acre). This high return per acre for vegetables should have driven many more acres of production toward vegetables than it has. The reason for a continued growth of field crops relative to vegetables, rather than the reverse, can be found in Table 6.6, which gives capital costs associated with each major crop. Vegetable crops are three to nine times more capital intensive than field crops. Thus the increased dollar yield per acre of vegetable crops does not represent a significantly higher rate of return on initial investment.

6.3 IMPERIAL COUNTY EMPLOYMENT AND LABOR FORCE

Nonagricultural Employment

Employment data for Imperial County are compiled annually according to nonagricultural employment categories by the State Office of Employment Data and Research and are presented for 1971 to 1975 in Table 6.7. There is a general similarity between the employment category headings in Table 6.7 and the major economic sector divisions in section 6.1 (Table 6.1). Over the 6-yr period covered by Table 6.7, county manufacturing employment rose 26.7%, about the same as most other sectors. However essentially all of this growth came under Other manufacturing (81.8% growth) and is associated primarily with the new industrial activities listed in Table 6.3. Food manufacturing employment rose much less than did other sectors, while stone, clay, and glass manufacturing was the only sector

Table 6.7. Imperial County nonagricultural employment.[12,13]

Employment category	1970 Mar.	1970 Jun.	1970 Sep.	1970 Dec.	1971 Mar.	1971 Jun.	1971 Sep.	1971 Dec.	% Change[a]
Civilian labor force	26,550	26,800	22,900	27,500	29,500	29,450	24,900	29,050	+7.4
Unemployment	2,700	2,150	1,800	3,300	3,900	3,200	2,450	3,700	+31.3
Unemployment rate, seasonal adjustment	9.1	8.7	8.6	10.8	11.9	11.9	10.6	11.4	+22.6
Unemployment rate	10.2	8.0	7.9	12.0	13.2	10.9	9.8	12.7	+10.7
Total civilian employment	23,850	24,650	21,100	24,200	25,600	26,250	22,450	25,350	+ 4.9
Self employed	2,400	2,400	2,400	2,400	2,450	2,450	2,450	2,450	+ 2.1
Domestics	350	350	350	350	350	350	350	350	0
Job based									
Nonagricultural wage and salary	18,000	19,250	17,800	18,350	18,300	19,300	18,050	18,500	+ 1.1
Manufacturing	1,450	1,750	1,450	1,350	1,300	1,650	1,450	1,350	- 3.3
Food and kindred	450	750	550	400	450	750	550	400	0
Stone, clay, and glass	400	400	400	400	400	400	400	400	0
Other manufacturing	600	600	500	550	450	500	500	550	- 9.1
Nonmanufacturing	16,550	17,500	16,350	17,000	17,000	17,650	16,600	17,150	+ 1.5
Construction	500	600	550	550	550	600	500	550	0
Transportation, communications, utilities	1,100	1,100	1,050	1,100	1,100	1,200	1,100	1,050	+ 4.8
Trade	5,800	6,400	5,400	6,000	5,800	6,500	5,550	5,950	0
Wholesale	1,400	2,050	1,050	1,250	1,300	2,050	1,000	1,000	-10.7
Retail	4,400	4,350	4,350	4,750	4,500	4,450	4,550	4,950	+ 3.1
Finances, insurance, and real estate	500	500	500	500	500	500	500	550	0
Services	2,400	2,350	2,300	2,300	2,400	2,400	2,400	2,450	+ 2.1
Government	6,250	6,550	6,550	6,550	6,650	6,450	6,550	6,600	+ 2.3
Federal	950	950	1,000	1,000	1,100	1,050	1,050	1,000	+10.5
State and local	5,300	5,600	5,550	5,550	5,550	5,400	5,500	5,600	+ 1.0

[a]Based on annual average change from 1971 to 1972, from 1972 to 1973, etc.

Table 6.7. (Continued)

Employment category	1972 Mar.	1972 Jun.	1972 Sep.	1972 Dec.	% Change	1973 Mar.	1973 Jun.	1973 Sep.	1973 Dec.	% Change
Civilian labor force	28,950	29,000	25,450	27,750	+ 4.4	28,800	29,000	26,300	30,450	+ 2.0
Unemployment	3,500	2,800	2,400	3,100	- 6.4	3,450	3,300	3,300	3,850	+15.3
Unemployment rate, seasonal adjustment	11.0	10.6	10.0	10.0	- 7.0	11.0	12.4	13.1	11.4	+13.3
Unemployment rate	12.1	9.7	9.4	11.2	- 7.0	12.0	11.4	12.5	12.6	+13.3
Total civilian employment	25,450	26,200	23,050	24,650	+ 1.6	25,350	25,700	23,000	26,600	+ 0.4
Self employed	2,450	2,450	2,450	2,450	0	2,450	2,450	2,450	2,450	0
Domestics	350	350	350	350	0	350	350	350	350	0
Job based										
Nonagricultural wage and salary	18,900	19,650	19,200	19,450	+ 3.3	20,300	20,850	20,200	21,250	+ 7.6
Manufacturing	1,350	1,700	1,500	1,350	0	1,600	1,850	1,600	1,650	+17.2
Food and kindred	500	750	550	400	0	550	750	500	550	+ 9.1
Stone, clay, and glass	400	400	450	450	0	400	400	400	350	0
Other manufacturing	450	550	500	500	0	650	700	700	750	+40.0
Nonmanufacturing	17,550	17,950	17,700	18,100	+ 3.5	18,700	19,000	18,600	19,600	+ 6.8
Construction	600	750	650	600	+ 9.1	650	650	600	650	+ 8.3
Transportation, communications, utilities	1,100	1,100	1,050	1,100	- 4.6	1,100	1,200	1,150	1,300	+ 9.5
Trade	5,800	6,050	5,750	6,300	0	6,450	6,650	6,300	6,850	+11.2
Wholesale	1,150	1,300	1,050	1,100	-12.0	1,400	1,700	1,400	1,500	+31.8
Retail	4,650	4,750	4,700	5,200	+ 3.3	5,050	4,950	4,900	5,350	+ 6.4
Finances, insurance, and real estate	550	550	550	550	+10.5	600	550	550	550	0
Services	2,650	2,600	2,700	2,600	+10.4	2,700	2,650	2,650	2,650	0
Government	6,850	6,900	7,000	6,950	+ 4.6	7,200	7,300	7,350	7,600	+ 5.8
Federal	1,000	1,000	1,050	1,000	- 4.8	1,000	1,000	1,000	1,000	0
State and local	5,850	5,900	5,950	5,950	+ 6.3	6,200	6,300	6,350	6,600	+ 6.8

Table 6.7. (Continued)

Employment category	1974 Mar.	1974 Jun.	1974 Sep.	1974 Dec.	% Change	1975 Mar.	1975 Jun.	1975 Sep.	1975 Dec.	% Change	Net change 1970 - 1975
Civilian labor force	30,100	31,750	28,550	32,750	+ 7.9	31,350	33,400	30,200	33,700	+ 4.6	+ 24.5
Unemployment	3,300	3,450	3,950	4,300	+ 8.8	3,900	5,900	5,350	4,550	+29.7	+100.0
Unemployment rate, seasonal adjustment	10.2	11.8	14.4	11.9	+ 0.8	11.6	19.2	18.3	12.2	+24.8	+ 62.4
Unemployment rate	11.0	10.9	13.8	13.1	+ 0.8	12.4	17.7	17.7	13.5	+23.1	+ 44.7
Total civilian employment	26,800	28,300	24,600	28,450	+ 7.8	27,450	27,500	24,850	29,150	+ 2.0	+ 17.8
Self employed	2,450	2,450	2,450	2,450	0	2,450				0	+ 2.1
Domestics	350	350	350	350	0	350				0	0
Job based											
Nonagricultural wage and salary	21,400	21,850	21,300	22,250	+ 5.1	22,350	22,750	22,250	23,650	+ 6.0	+ 25.3
Manufacturing	1,650	2,000	2,000	1,900	+ 8.8	1,900	2,150	1,900	1,700	+ 2.7	+ 26.7
Food and kindred	500	700	650	550	0	500	750	550	600	0	+ 9.1
Stone, clay, and glass	350	350	350	350	-12.5	300	300	350	350	- 7.1	- 18.8
Other manufacturing	800	950	1,000	1,000	+28.5	1,100	1,100	1,000	750	+11.1	+ 81.8
Nonmanufacturing	19,750	19,850	19,300	20,350	+ 4.8	20,450	20,600	20,350	21,950	+ 5.3	+ 24.0
Construction	650	700	600	600	0	600	700	700	600	0	+ 18.2
Transportation, communications, utilities	1,300	1,450	1,350	1,450	+17.4	1,400	1,500	1,350	1,300	0	+ 28.6
Trade	6,800	6,650	6,400	7,250	+ 3.9	6,950	6,950	6,750	8,500	+ 4.5	+ 37.9
Wholesale	1,850	1,600	1,350	1,950	+13.8	1,850	1,800	1,450	2,700	+12.1	+ 32.1
Retail	4,950	5,050	5,050	5,300	+ 1.0	5,100	5,150	5,300	5,800	+ 5.9	+ 21.6
Finances, insurance, and real estate	650	650	600	600	+ 9.1	650	650	650	600	+ 4.2	+ 25.0
Services	2,800	2,800	2,800	2,800	+ 5.7	3,000	2,950	3,050	3,000	+ 7.1	+ 27.7
Government	7,550	7,600	7,550	7,650	+ 2.1	7,850	7,850	7,850	7,950	+ 4.3	+ 22.1
Federal	1,050	1,000	1,000	1,000	0	1,000	1,000	1,000	1,100	+ 2.5	+ 7.9
State and local	6,500	6,600	6,550	6,650	+ 4.0	6,850	6,850	6,850	6,850	+ 4.6	+ 24.5

to actually decline over that 6-yr period. Federal government employment, as is very common when at a distance from major federal installations, rose very slowly; however, state and local government employment increased by 24.5% or at an even pace with most of the private sector. Unemployment in Imperial County, as in most areas of the state, climbed dramatically over this period. It is noteworthy, however, that the largest single rise in unemployment occurred in 1975 — a period when most areas were beginning to reduce local unemployment rates. Futhermore, the unemployment rate in Imperial County throughout this entire period is higher than might be expected. The employment of Mexican green card holders in various labor fields (see subsection below on Mexican labor force) should act as a partial buffer against a high county unemployment rate since, although unemployed, green card holders are not counted in unemployment figures. Thus unemployment rates should not reflect total unemployment, but rather total unemployment less green card holder unemployment.

Some perspective on the stability of various industries can be obtained from Table 6.7. Wholesale activity was the least stable over this 6-yr period within the Imperial County economy with annual percentage changes of: -10%, -12%, +31.8%, and +12.1%. The general class of Other manufacturing followed closely behind with changes of -9.1%, 0%, +40.0%, +28.5%, and +11.1%. The large 1973 jump is, again, the result of the advent of new industries listed in Table 6.3. Manufacturing as a whole was much more stable than Other manufacturing primarily because of the size of the local food and kindred manufacturing force. Construction, traditionally a nonstable sector, was unusually stable in Imperial County over this period, showing good gain in 1973 and 1974 and no growth in the other 3 years.

In addition to employment data collected industry by industry by the Department of Commerce, data are also collected as part of the census survey for employment by job class. The data from the 1970 census are shown on Table 6.8. While this type of data complements SIC employment figures, no direct industry-by-industry comparison is possible with the data in their present form. The SIC employment figures give the number of persons employed by a given activity regardless of their job class (clerical, craftwork, manager, etc.), and the census data present total county employment for each job class regardless of the industry employing the individuals.

Table 6.8. Imperial County employment by job class (1970).[14]

Job class	1970 Employment	%
Civilian labor force	25,257	(100)
Employed	23,479	100%
Professional, technical and related	2,489	10.6
Engineers	94	0.4
Medical and health	329	1.4
Teachers (grades K to 12)	986	4.2
Nonfarm managers and administrators	2,418	10.3
Sales workers	1,597	6.8
Clerical workers	3,592	15.3
Craftsmen, foremen and related	2,771	11.8
Construction craftsmen	704	3.0
Mechanics and repairmen	986	4.2
Machinist and other metal workers	47	0.2
Other	1,033	4.4
Operatives (except transport)	1,573	6.7
Transport operatives	1,150	4.9
Nonfarm laborers	1,057	4.5
Service workers	2,817	12.0
Private household workers	352	1.5
Farm workers	3,663*	15.6

*Does not include most migrant labor or Mexican green card labor.

Unemployment Characteristics and Current Employment Prospects.

Unemployment and employment levels for Imperial County are plotted together in Fig. 6.1 for 1970 through 1975 to show their relationship. Major annual drops in employment occur in late summer. These employment reductions correspond not to periods of increased registered unemployment, but rather to the annual low point for registered employment. Two factors can partially explain this phenomenon. First, most summer student help terminates in late summer and returns to school rather than entering unemployment rolls. Second, and by

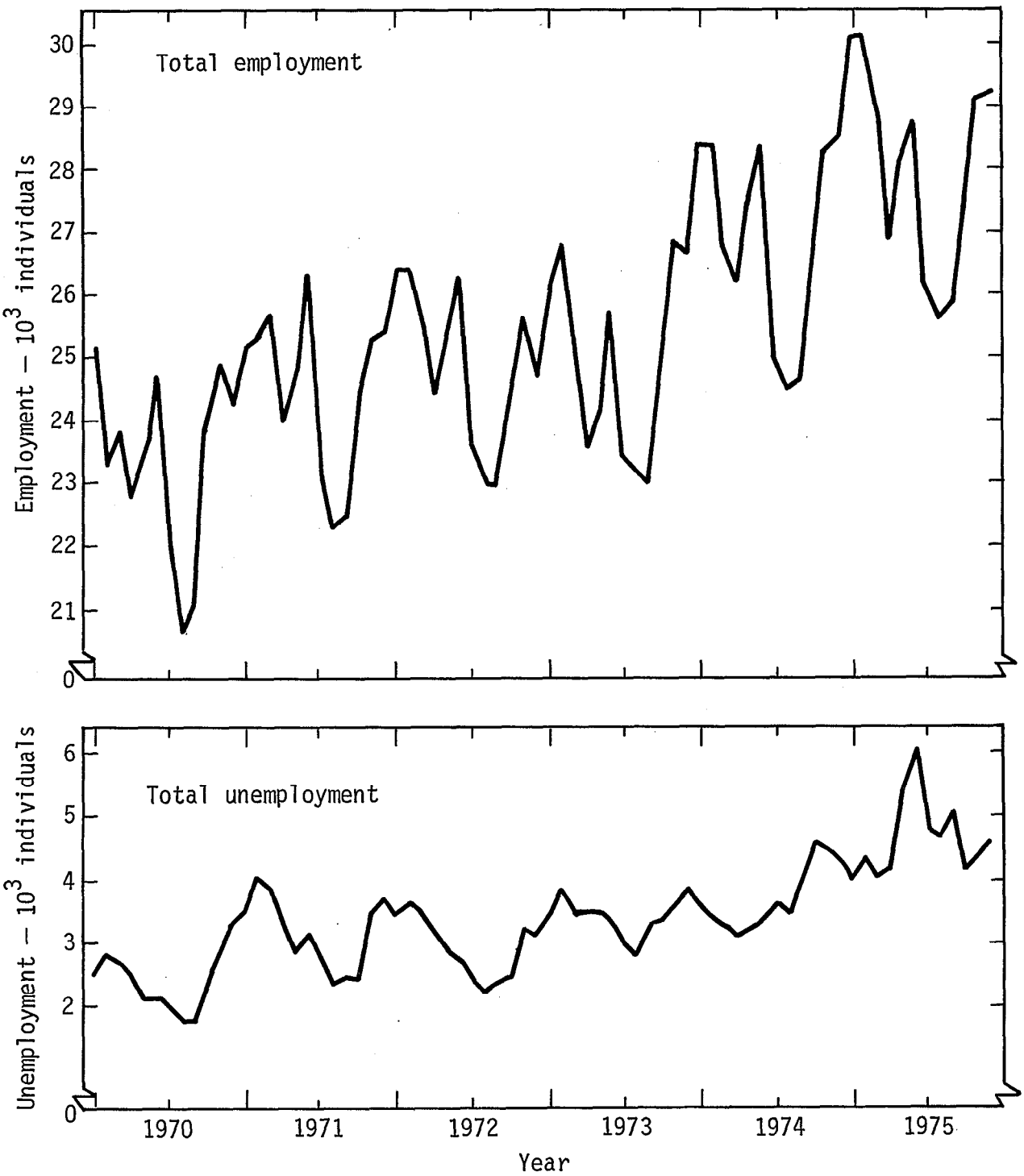


Fig. 6.1. Total employment and unemployment for Imperial County, 1970 to 1975.

far the larger effect, is an annual outmigration of transient, seasonal agricultural labor. Nonagricultural unemployment for the county shows very low annual fluctuations. Some statistics on registered unemployed persons as of 31 January 1976 are shown in Table 6.9. This breakdown shows no unique or unusual trends in Imperial County compared to other California counties. There is a high percentage of Spanish Americans on the county unemployment rolls; however their presence is not an intrinsic characteristic of the county economy but more significantly a function of its location. Seasonal and migrant farmworkers are not uncommon in an agriculturally based county.

Employment and labor opportunity trends are summarized monthly and projected annually by the Office of Employment Data and Research (EDR). Their data showed that in 1975 the employed labor force increased by 2000 persons, while net agricultural employment dropped. This large increase in nonagricultural employment was counterbalanced by an unemployment increase to 14.3% of the work force. Projections for 1976 show a slowed rate of net nonagricultural employment gain and, consistent with the projections made in Section 6.2, continued net agricultural employment reductions. Combined with the already high unemployment rate, this means that there will be an excess in total county labor supply throughout 1976 and into 1977.

Analyzing these EDR trends and projections on an industry-by-industry level, late 1975 employment increases were attributable to large increases in retail employment followed by smaller gains in construction, wholesale, transportation, utilities, and government. Manufacturing and finance remained unchanged while the services sector declined in employment. Steady growth is projected in retail and, to a lesser extent, in wholesale sectors throughout the foreseeable future. Employment levels for services and for finance, insurance and real estate are expected to be closely tied to population changes. If county population increases follow the growth pattern of the past 5 years, modest, steady increases will occur in service related employment. Manufacturing employment changes should be dependent on the creation of new industrial activities rather than on expansion of existing facilities, with construction employment being somewhat dependent on the influx of new industry. Transportation, communication and utilities are projected to remain relatively stable at current employment levels.

Table 6.9. Imperial County unemployment characteristics as of 31 January 1976.[13]

Characteristics of applicants	Total	Female	Economically disadvantaged	Handicapped	Minority			Welfare	Veteran			UI claimant	Seasonal worker	Age	
					Total	Black	Spanish American		Total	Vietnam era	Special Vietnam era			Under 22	45 or older
B	C	D	E	F	G	H	I	J	K	L	M	N	O	P	Q
Age	2216	942	1238	135	1499	118	1366	717	398	221	23	747	530	387	550
Under 20	175	58	96	3	114	9	104	35	8	8	1	48	37	175	0
20-21	212	80	110	2	141	15	126	37	32	30	3	71	37	212	0
22-24	276	90	119	-	192	15	176	57	65	64	10	111	61	0	0
25-29	326	119	155	13	224	19	204	97	73	71	5	125	76	0	0
30-39	468	251	293	29	297	27	264	208	66	34	2	148	93	0	0
40-44	209	111	147	20	159	10	147	101	24	6	2	70	70	0	0
45-54	373	179	233	42	258	14	242	141	86	7	0	122	98	0	373
55-64	151	49	78	19	99	9	90	41	37	1	0	41	46	0	151
65 and over	26	5	7	3	15	0	13	0	7	0	0	11	12	0	26
Sex	2216	-	1238	135	1499	118	1366	717	398	221	23	747	530	387	550
Male	1274	0	645	92	843	59	776	301	393	218	23	476	359	249	317
Female	942	-	593	43	656	59	590	416	5	3	0	271	171	136	233
Highest school grade	2216	942	1238	135	1499	118	1366	717	398	221	23	747	530	387	550
0-7	667	323	460	48	627	14	610	289	26	2	0	226	294	24	311
8-11	720	295	444	54	485	45	436	267	117	56	9	223	163	178	129
12	573	230	241	17	266	42	220	123	173	120	8	199	54	147	73
Over 12	256	94	93	16	121	17	100	38	82	43	6	99	19	38	37
Residence	2216	942	1238	135	1499	118	1366	717	398	221	23	747	530	387	550
Urban	1907	802	1084	110	1329	113	1206	633	344	194	21	637	447	332	474
Rural	309	140	154	25	170	5	160	84	54	27	2	110	83	55	76

Table 6.9. (Concluded)

Characteristics of applicants	Total	Female	Economically disadvantaged	Handicapped	Minority		Spanish American	Welfare	Veteran		Special Vietnam era	UI claimant	Seasonal worker	Age	
					Total	Black			Total	Vietnam era				Under 22	45 or older
B	C	D	E	F	G	H	I	J	K	L	M	N	O	P	Q
Ethnic group	2216	942	1238	135	1499	118	1366	717	398	221	23	747	530	387	550
White	2057	858	1131	128	1354	0	1354	635	377	210	22	708	514	361	516
Black	118	59	76	5	118	-	3	53	16	8	1	30	13	24	23
American Indian	10	5	9	1	10	0	2	9	2	2	0	1	1	0	0
Other	15	6	6	1	15	0	5	3	3	1	0	5	2	1	8
Ina	16	14	16	0	2	0	2	16	0	0	0	3	0	1	3
Spanish American	1366	590	847	71	1366	3	-	485	138	90	11	491	455	230	345
UI claimant	747	271	320	27	523	30	491	138	133	85	7	-	218	119	174
State	581	226	229	22	400	24	375	111	85	45	2	581	146	87	130
Veteran	398	5	166	40	158	16	138	53	-	221	23	133	51	40	130
Recently separated	130	2	53	5	62	5	56	12	130	130	15	60	16	34	7
Vietnam era	221	3	90	13	101	8	90	34	221	-	22	85	22	38	8
Special Vietnam era	22	0	15	1	12	1	11	5	22	22	-	7	7	4	0
Disabled	20	0	9	15	5	0	5	2	20	10	1	5	3	1	9
Handicapped	135	43	100	-	78	5	71	81	40	13	2	27	23	5	64
Economically disadvantaged	1238	-	1238	100	934	76	847	679	166	90	15	320	291	206	318
Food stamp	409	179	378	50	293	27	266	233	39	23	5	94	95	64	117
Welfare	717	416	679	81	548	53	485	-	53	34	5	138	89	72	182
WIN	693	407	655	80	533	53	470	693	48	31	4	135	82	68	178
CETA	9	4	9	1	6	0	6	8	1	1	0	1	0	3	2
Seasonal farmworker	530	171	291	23	468	13	455	89	51	22	7	218	-	74	156
Migrant farmworker	223	63	113	7	191	3	187	23	26	11	2	84	223	31	66

As of March 1976, the State Employment Development Department (EDD) forecast little activity in hiring for professional skills in all employment sectors. Clerical placement prospects are good to fair in retail, wholesale, and government sectors, and slow in other sectors.[15] Sales and general service employment is projected to be slow because of excess labor supplies. Specialized industrial and construction workers are relatively easy to place, especially in El Centro and Imperial; however most construction and manufacturing jobs are unionized and are therefore hired through union halls. Little data on these types of positions are available through EDD.

Mexican Labor Force in Imperial County

Staff workers for the Community Services Agency sponsored organization Campesinos Unidos, which is based in Brawley, have gathered considerable unpublished data on the magnitude of the Mexican Labor Force in Imperial County.[16] Robert E. Nilan, U.S. Immigration Service, Calexico, reported that approximately 20% of the Imperial Valley population are permanent U.S. resident aliens. This labor force is treated statistically as resident labor. Daily commuting green card holders, however, have a much greater impact on the county. This group acts as an impact buffer for Imperial County employment by absorbing a percentage of sudden changes in demand for employment, thus reducing the fluctuation in employment and unemployment felt by the county and local governments. The distribution of these green card workers throughout the county economy for a single 3-month period is shown in Table 6.10. These figures are somewhat misleading since late summer is the annual employment low for agriculture. Unofficial county staff estimates have put peak agricultural green card employment at between 6500 and 8000 daily. To place this volume of traffic in better perspective, daily border crossings were tabulated at each border station and reported by Campesinos Unidos.[16] Annual border crossings at Calexico ranged from 12.5 million in 1970 to 15.7 million in 1974. (Green card workers represent slightly over 14.0% of all border crossings.)

Imperial County Agricultural Employment

Agricultural employment data for both seasonal and regular hire labor is gathered for Imperial County by EDR. Their 1976 projection for most Imperial Valley crops is

Table 6.10. Imperial County daily Mexican green card holder work force for July through Sept. 1975.[a]

Sector	Number of alien commuters (Mexican residence) identified		
	July, 1975	August, 1975	September, 1975
Agriculture	4,901	4,911	4,953
Industry	126	138	153
Construction	44	44	42
Sales/service	238	243	248
Domestic	38	37	39
Other	37	37	37
	5,384	5,410	5,472

[a]From Pepe Renaldo, Imperial Valley Characterization for Campesinos Unidos (unpublished).[16]

shown in Table 6.11. A simple breakdown into regular hired, farmer/owner and unpaid family, and seasonal workers for some crops is given in Table 6.12. The nonseasonal workforce for most crops is minimal. No shortage of agricultural labor to meet these large seasonal demands is forecast for 1976 to 1977.

The only long term trend in county agricultural employment is a general, steady downward trend. In their Ultimate Land Use Plan,[3] the county planning staff reports a 48% decrease in agricultural employment over the period of 1960 to 1972. With a continued trend toward mechanization, this decline in agricultural employment should continue.

6.4 IMPERIAL COUNTY ELECTRICAL ENERGY BUDGET

Since geothermal resources will be used primarily for electrical power production, a brief characterization of Imperial County's electrical energy use patterns is pertinent. Table 6.13 shows the county electrical energy budget for 1972, 1974, and 1975. Table 6.14 shows the distribution of sales and use of electrical energy within the county and the relative rank of Imperial County in 1972 among the 58 California counties for each sales and use

Table 6.11. Imperial County total agricultural employment[a] by crop by month projected for 1976.[17]

Crop	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sept	Oct	Nov	Dec
Vegetable												
Lettuce	4,700	4,225	1,185	0	0	0	0	0	0	0	100	1,700
Carrot	160	150	165	155	120	70	0	0	0	0	0	90
Onion	100	250	150	40	600	450	50	0	0	0	60	80
Asparagus	180	1,100	960	550	180	0	0	0	0	0	0	0
Tomato	130	150	125	175	175	675	375	0	0	0	0	0
Broccoli	150	50	0	0	0	0	0	0	10	50	60	60
Other	950	750	480	360	225	225	170	190	240	385	775	950
Field crops												
Sugar beets	450	550	600	550	425	500	275	0	350	1,200	1,200	600
Cotton	175	100	0	10	500	450	325	170	30	10	375	325
Hay-alfalfa	50	60	80	120	300	340	300	400	280	200	70	60
Other field crops	2,000	1,900	1,825	2,075	2,450	2,050	1,600	1,400	1,700	2,050	2,275	2,040
Orchards	100	100	50	45	90	100	55	40	40	40	85	100
Livestock	1,000	1,000	1,000	1,000	1,000	1,000	1,000	1,000	1,000	1,000	1,000	1,000
Miscellaneous	140	150	145	140	130	160	135	135	135	130	140	150
Specialty crops	425	550	475	400	400	600	425	400	380	360	425	475
Total	10,760	11,085	7,240	5,620	6,595	6,620	4,710	3,735	4,165	5,425	6,565	7,630

[a]Man months/month required labor.

Table 6.12. Imperial County expected crop employment by employment category for 1976.[17]

Crop	Total annual labor (man weeks)			Percent of total		
	Farmer/family	Regular hire	Seasonal	Farmer/family	Regular hire	Seasonal
Cotton	340	460	9,510	3.3	4.5	92.2
Miscellaneous vegetables	520	520	5,880	7.5	7.5	85.0
Tomatoes	580	870	6,150	7.7	11.6	82.0
Sugar beets	660	1,140	26,040	2.4	4.1	93.5
Asparagus (harvest)	190	190	11,490	1.6	1.6	96.8
Broccoli	0	0	1,370	0	0	100.0
Lettuce	510	1,340	62,680 43,700	0.8	2.8	96.4

category. Per capita rankings on Table 6.14 are rankings of each category kWhr divided by county population. Per capita energy use in Imperial County ranks significantly higher than total energy use for most categories; as a result of large scale water pumping for irrigation, the public use category for Imperial County ranks 23rd overall and 12th on a per capita basis.

Imperial Irrigation District (IID) is responsible for generation, import, export, and sales of all electrical energy within the county. As of 1972, IID was 1 of 24 active electrical energy generating companies in California, producing 782,264,421 kWhr or 0.61% of the state total.[18] IID was also 1 of 45 companies making direct electrical sales to consumers and sold 988,726,154 kWhr or 0.71% of the state total. In addition they used 10,729,210 kWhr (primarily for irrigation water pumping) without direct consumer charge for a total sales and nonsales use (total use) of 999,455,364 kWhr or 0.69% of the state total. Their sales totaled $15,447,041 in 1972 or 0.65% of the state total utility revenue from sales to ultimate consumers. Thus IID's average sales rate fell slightly below the state average for that year. IID system losses (line losses, conversion losses, etc.) were 130,230 MWhr or 11.52% of company total electrical energy. This figure is higher than state average, especially in light of the relatively small area covered by IID.

6.5 IMPERIAL COUNTY ECONOMIC CHARACTERIZATION AND COMPARISON TO OTHER CALIFORNIA COUNTIES.

The information listed in the previous sections must be placed in some perspective for that information

Table 6.13. Imperial County electrical energy budget for 1972, 1974, 1975.[18]

	1972		1974		1975	
	kWhr	Intracounty dollar flow	kWhr	Intracounty dollar flow	kWhr	Intracounty dollar flow
Energy generation						
Steam	527,193,700		575,773,800		556,619,500	
Hydroelectric	254,305,181		266,139,502		264,006,194	
Other	1,431,389		25,298,639		10,456,921	
Energy imports						
USBR	232,425,378	-$1,187,745	216,745,747	-$1,349,743	225,565,355	-$1,319,586
SCE	107,453,242	-$1,211,240	128,720,462	-$2,220,769	156,699,648	-$3,618,042
Yuma County	1,248,753	-$ 4,059	1,339,724	-$ 4,354	814,728	-$ 2,648
SDGE	4,000	-$ 35	0	0	0	0
IID Riverside plants	1,608,630	0	9,365,621	0	3,871,179	0
Exports						
SDGE	- 19,200	+$ 133	568,000	+$ 4,672	449,600	+$ 8,851
Riverside County sales	328,460,167	+$5,149,680	310,096,739	+$6,301,695	313,450,270	+$7,982,690
Total available to county	802,215,118	(+$2,746,734)	912,718,756	(+$2,731,501)	904,143,655	(+$3,051,265)
Imperial County Total sales	660,265,987		759,202,361		767,412,730	
Nonsales uses	10,729,210		9,962,519		9,274,093	
Losses	130,229,921		142,148,552		127,078,804	
Discrepancy	0		+ 1,045,323		- 378,028	
% Increase in-county sales	X		+ 15.0%		+ 1.1%	

Table 6.14. Imperial County electrical energy sales and use data for 1972.[18]

	County total			Per capita
	kWhr	% State total	Rank	Rank
Population		0.38	32	32
Residential electrical sales	276,337,423	0.69	28	16
Commercial sales	256,908,979	0.54	30	15
Industrial sales	76,738,153	0.19	30	34
Sales to public sector	50,525,443	0.47	22	12
Total commercial use	256,921,968	0.54	30	16
Total industrial use	76,738,153	0.19	30	34
Total public use	61,254,653	0.39	23	12
Total sales	660,950,998	0.47	28	19
Total use	671,252,176	0.46	29	20

to be usable for analytical purposes. County Business Pattern information for all 58 California counties was compiled for comparative analysis by calculating the following parameters:

- Location quotients were calculated for 83 SIC industries, including all 1-digit, many 2-digit, and selected 3- and 4-digit SIC codes. A location quotient measures the presence of a given activity (SIC employment) in a county relative to the presence of that activity in the state as a whole. By definition,

$$\text{Location quotient} = \frac{\dfrac{\text{County SIC employment}}{\text{County total employment}}}{\dfrac{\text{State SIC employment}}{\text{State total employment}}}$$

A value of 1 indicates that an activity is present in a county to the same extent that it is present in the state as a whole. A very high value indicates that an activity is present in an inordinately high percentage in a county, that the county exports some or most of the products associated with that activity, and that the county is an improtant element in the state economy for that activity. Coefficients of localization were calculated, based on data provided by Lofting[2] for 1972 agricultural activity as whole, crop related employment, and beef, cattle, and other livestock

employment. Detailed data on Imperial County crop-by-crop employment have been collected and were presented in section 6.3. It would be desirable to calculate coefficients of localization for each of these specific crops; however such information has not been gathered for other counties or for the state as a whole. Thus, only general calculations are feasible at this time.

While a location quotient compares the relative presence of each element within one subregion (county) to that for each element within a larger base economy (state), a coefficient of localization compares the relative presence of a single economic element (SIC) within each subregion of the base economy. Thus a coefficient of localization provides an index of the extent to which an industry is evenly spread among the counties of a state or is concentrated in only a few counties. The coefficient of localization varies from 0 to 1, with low values indicating a high degree of diversification and high values indicating a high degree of localization. Primary activities (agriculture, mining, etc.) typically have fairly high coefficients of localization (greater than 0.4), while secondary activities such as manufacturing are in the 0.3 to 0.55 range, and tertiary activities (wholesale, retail, services) have very low values (typically around 0.2).

By definition,

$$\text{Coefficient of localization}_i = \frac{\sum_{j=1}^{n} d_j, \text{ for all } d > 0}{100},$$

where n = number of counties within the state

and $d_j = \frac{\text{County}_j \text{ employment for SIC}_i}{\text{Total county}_j \text{ employment}} - \frac{\text{State employment for SIC}_i}{\text{Total state employment}}$.

- Indices of diversification were calculated for each county economy. This index is similar to the location quotient in that it indicates the distribution of activities in each subregion or county. However the index of diversification provides a single coefficient as a measure of the relative diversification of each county economy. The index of diversification varies from 0 to 1 with low values indicating a more diverse economy. This study uses the following form for calculation of

the refined index of diversification (RID):

$$RID = \frac{SA - AD}{AN - AD} ,$$

where SA = crude index of diversification for the study area,

AD = crude index of absolute diversification, and

AN = crude index of absolute nondiversification

Isard[19] has provided the methodology for computing crude indices of diversification. Typical state and county RID's are graphed with AN and AD in Fig. 6.2. RID's were calculated for each county with data from major industrial divisions only. The sectors covered are: agriculture; agricultural service; mining; contract construction; manufacturing; transportion and public utilities; wholesale; retail; finance, insurance, and real estate; and personal services. An RID graph covering these sectors for Imperial County is shown in Fig. 6.3.

Data for these three parameters are contained in Tables 6.15, 6.16, and 6.17, respectively. RID elements for Imperial County are plotted with AN and AD in Fig. 6.3. Table 6.18 shows the SIC numbers analyzed in Tables 6.15 and 6.16, and associated sector titles. The Imperial County sectors with exceptionally high location quotients are listed in Table 6.19 and compared to Kern and Fresno counties (two other agriculturally based counties) in Table 6.20.

Location quotient data contained in Table 6.15 is relatively self-explanatory. Imperial County is weak in mining and manufacturing, close to average in retail, finance and services, slightly above average

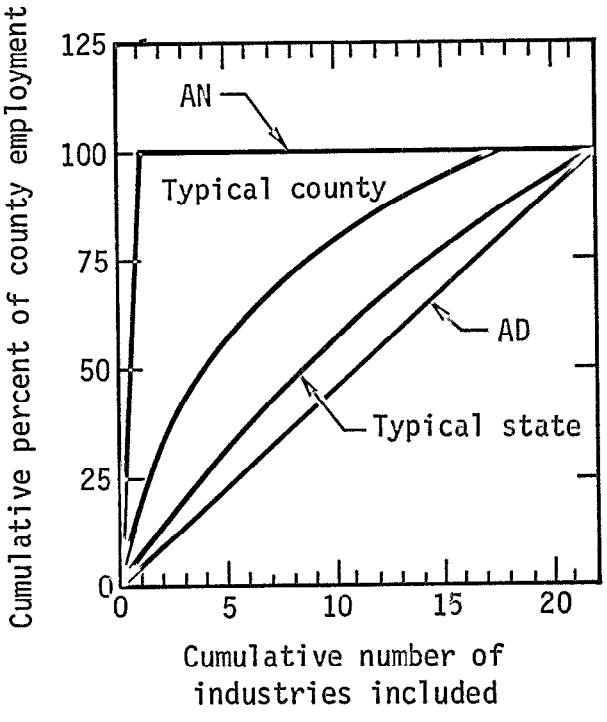
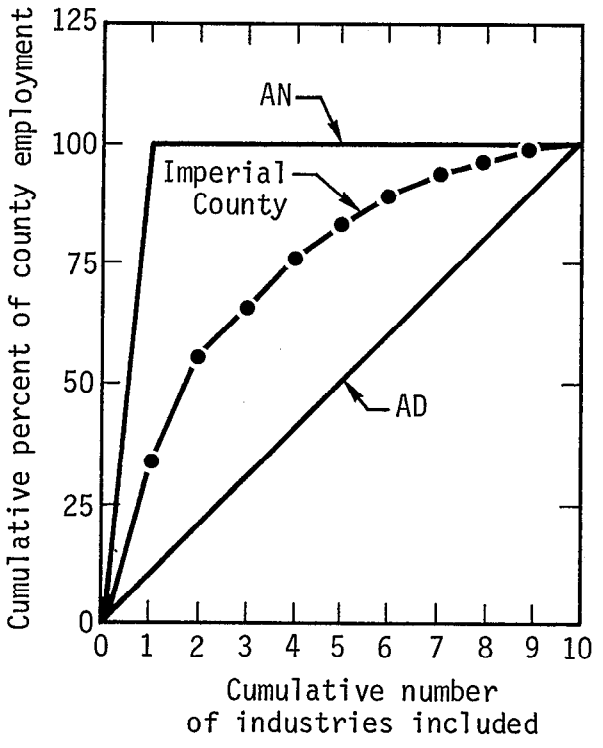


Fig. 6.2. Typical state and county diversity graphs. AN = crude index of absolute nondiversification; AD = crude index of absolute diversification.



Industry rank	Industry name	% of County employment
1	All agriculture	33.41
2	Retail	22.40
3	Services	10.01
4	Transportation, communication, public utility	9.97
5	Manufacturing	7.20
6	Wholesale	6.95
7	Agricultural services	3.33
8	Finance, insurance, and real estate	3.05
9	Contract construction	3.03
10	Mining	0.08

Fig. 6.3. Imperial County diversification graph. AN = crude index of absolute nondiversification; AD = crude index of absolute diversification.

in wholesale sectors, and substantially above average in utilities and agriculturally related areas. The extremely high location quotients for individual sectors associated with public utilities functions (SIC #'s 4000, 4900, 4931, 4950 and 4970) in Imperial County should be explained. In general, employment associated with utility companies structured similarly to IID is not recorded on County Business Patterns data. IID data were obtained from Lofting's employment figures[2] and were included with the County Business Patterns[1] data for these calculations to better represent total Imperial County employment. However, data were not available to make similar inclusions for other counties. Thus Imperial County appears artificially strong in these areas. Two of these sectors, 4900 and 4970, appear on Table 6.19 but should be disregarded because of this artificial bias.

The general coefficients of localization for the three agricultural divisions are well within the normal range for primary activities. Crop related agriculture shows less diversity than does beef, cattle, and livestock. This difference, however, is too small to be of any real significance.

In Table 6.18, Imperial County ranks 26th for overall county diversity with an RID of 0.5380, while it ranks 32nd for population, and 31st for total employment.

6.6 SUBCOUNTY ECONOMIC ANALYSIS

Agriculture

Having described the economy of Imperial County as a whole in previous

Table 6.15. County economic location quotients by sector.

COUNTY \ SIC NUMBER	07	10	15	1500	1600	1700	19	2000	2040	2060	2400
ALAMEDA	0.728	0.277	1.027	0.980	0.829	1.129	0.990	1.460	1.915	0.	0.371
ALPINE	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.
AMADOR	0.	7.260	6.426	21.061	0.	0.615	0.776	0.	0.	0.	20.185
BUTTE	1.314	0.097	1.014	1.065	0.881	1.046	0.622	0.967	0.	0.	9.149
CALAVERAS	0.	18.868	1.059	1.791	0.	0.367	0.882	0.	0.	0.	0.
COLUSA	0.	0.	1.136	0.	0.	0.	0.622	0.	0.	0.	0.
CONTRA COSTA	1.090	0.354	1.767	1.532	2.634	1.586	0.926	0.715	0.	14.724	0.159
DEL NORTE	0.	0.121	0.190	0.	0.	0.	1.894	0.	0.	0.	56.343
EL DORADO	0.	2.213	1.124	1.672	0.845	0.970	0.418	0.	0.	0.	10.150
FRESNO	1.818	0.964	1.287	1.306	1.309	1.288	0.695	2.096	1.103	4.429	1.494
GLENN	0.	0.971	0.477	0.	0.	0.349	0.787	4.886	0.	101.494	0.
HUMBOLT	0.628	0.061	0.575	0.420	0.813	0.574	1.464	0.697	0.	0.	35.433
IMPERIAL	10.174	0.226	0.806	0.748	0.994	0.776	0.403	1.403	11.028	14.784	1.167
INYO	0.	33.956	0.536	0.903	0.	0.435	0.149	0.	0.	0.	0.
KERN	2.242	20.349	1.087	0.893	1.445	1.064	0.497	0.818	0.	0.	0.678
KINGS	2.622	2.101	0.875	1.325	0.804	0.689	1.006	3.467	16.756	0.	0.
LAKE	0.	0.266	1.076	0.767	0.	0.847	0.212	0.	0.	0.	0.
LASSEN	0.	0.326	0.287	0.	0.	0.	0.824	0.	0.	0.	24.601
LOS ANGELES	0.570	0.789	0.774	0.734	0.752	0.802	1.186	0.767	0.926	0.	0.387
MADERA	2.321	0.223	0.933	1.464	0.	0.736	1.028	5.943	0.	0.	3.576
MARIN	3.061	0.383	1.424	2.198	0.897	1.253	0.342	0.	0.	0.	0.
MARIPOSA	0.	2.313	0.589	0.	0.	0.	0.089	0.	0.	0.	0.
MENDOCINO	0.	0.581	0.649	1.082	0.864	0.360	1.436	0.578	0.	0.	38.400
MERCED	2.730	0.	1.246	1.943	0.868	1.055	0.578	2.057	0.	0.	0.
MODOC	0.	27.256	0.502	0.	0.	0.	0.677	0.	0.	0.	20.398
MONO	0.	6.951	2.480	8.053	0.	0.	0.095	0.	0.	0.	0.
MONTEREY	2.349	1.970	1.071	1.458	0.935	0.944	0.591	2.822	0.	17.527	0.
NAPA	0.814	0.029	1.167	1.407	0.859	1.179	0.808	1.777	0.	0.	0.
NEVADA	0.	2.518	0.822	1.334	0.	0.756	0.579	0.	0.	0.	11.526
ORANGE	1.129	0.850	1.122	0.973	0.644	1.387	1.202	0.514	0.	0.	0.427
PLACER	1.103	0.704	1.225	1.922	1.202	0.902	0.451	0.	0.	0.	4.950
PLUMAS	0.	1.015	0.505	0.	0.	0.	1.544	0.	0.	0.	47.592
RIVERSIDE	3.000	0.624	1.297	1.141	1.045	1.149	0.781	0.489	1.859	0.	0.899
SACRAMENTO	0.750	0.353	1.431	1.418	1.120	1.562	0.439	1.319	0.915	0.	0.825
SAN BENITO	6.118	8.615	0.952	2.272	0.	0.503	1.616	8.059	0.	0.	0.
SAN BERNARDINO	0.978	2.536	1.265	1.306	1.254	1.264	0.823	0.939	1.051	0.	0.505
SAN DIEGO	1.010	0.342	1.394	1.341	0.987	1.589	0.783	0.475	0.	0.	0.166
SAN FRANCISCO	0.209	0.107	0.987	0.921	1.534	0.754	0.511	0.840	0.	0.	0.117
SAN JOAQUIN	1.423	0.266	1.162	1.037	1.689	1.045	0.948	3.876	8.268	14.808	2.816
SAN LUIS OBISBO	1.947	0.330	2.069	3.667	1.685	1.439	0.310	0.485	0.	0.	0.
SAN MATEO	0.977	0.102	1.375	1.320	2.512	0.885	0.716	0.615	0.	0.	0.159
SANTA BARBARA	2.439	3.414	1.062	1.186	1.132	0.990	0.651	0.992	0.	6.556	0.247
SANTA CLARA	0.775	0.100	0.991	1.072	0.723	1.064	1.456	1.287	0.	0.	0.270
SANTA CRUZ	1.289	0.616	1.115	1.321	0.966	1.083	0.960	4.499	0.	0.	3.154
SHASTA	0.932	0.294	1.294	0.886	3.275	0.779	0.907	0.	0.	0.	17.425
SIERRA	0.	2.810	0.259	0.	0.	0.	2.184	0.	0.	0.	68.627
SISKIYOU	0.	0.212	0.794	1.037	1.749	0.326	1.193	0.	0.	0.	34.505
SOLANO	0.839	1.705	1.080	0.729	0.692	1.417	0.483	2.132	3.862	0.	0.
SONOMA	1.699	0.760	1.308	2.279	0.704	1.065	0.658	1.365	0.	0.	6.464
STANISLAUS	1.901	0.293	1.181	1.798	0.548	1.126	1.248	8.270	5.929	0.	0.857
SUTTER	2.165	4.707	0.992	1.653	0.	0.819	0.715	1.784	0.	0.	10.699
TEHAMA	0.	0.	0.581	1.029	0.	0.446	1.753	2.147	0.	0.	46.071
TRINITY	0.	1.787	0.150	0.	0.	0.	1.929	0.	0.	0.	57.283
TULARE	10.824	0.268	1.267	1.764	1.014	1.122	0.751	1.402	0.	0.	2.435
TUOLUMNE	21.508	0.706	1.490	1.939	2.680	0.842	0.671	0.	0.	0.	18.397
VENTURA	4.472	5.965	1.321	1.043	1.508	1.410	0.664	0.827	0.	0.	0.
YOLO	2.232	0.305	1.220	1.034	1.652	1.169	0.902	4.075	26.401	61.250	1.437
YUBA	0.	0.207	1.552	0.317	4.977	0.916	0.513	0.	0.	0.	7.426

Table 6.15. (Continued)

COUNTY \ SIC NUMBER	2700	2800	2870	3200	3900	40	4100	4200	4221	4700	4800
ALAMEDA	0.861	1.739	0.	2.365	0.533	1.215	1.474	1.827	0.	0.820	1.001
ALPINE	0.	0.	0.	0.	0.	0.180	0.	0.	0.	0.	0.
AMADOR	0.	0.	0.	0.	0.	0.711	0.	0.	0.	0.	0.
BUTTE	0.781	0.	0.	0.	0.	1.034	0.	0.765	0.	0.	1.470
CALAVERAS	0.	0.	0.	17.252	0.	1.020	0.	0.	0.	0.	0.
COLUSA	0.	0.	0.	0.	0.	0.875	0.	0.	0.	0.	0.
CONTRA COSTA	0.714	3.170	12.832	1.490	0.536	0.997	1.438	1.128	0.	0.442	0.941
DEL NORTE	0.	0.	0.	0.	0.	1.071	0.	2.380	0.	0.	0.
EL DORADO	0.	0.	0.	0.	0.	1.451	8.698	0.919	0.	0.	0.621
FRESNO	0.738	0.921	5.850	1.163	0.821	1.012	0.621	1.930	13.755	0.331	0.904
GLENN	0.	0.	0.	0.	0.	1.033	0.	2.026	0.	0.	0.
HUMBOLT	0.545	0.	0.	0.858	0.571	0.885	0.	1.111	0.	0.	0.737
IMPERIAL	0.693	0.923	14.574	3.731	0.584	1.990	1.613	1.582	66.952	0.563	0.816
INYO	0.	0.	0.	0.	0.	1.364	0.	0.	0.	0.	2.130
KERN	0.553	0.299	0.	1.472	0.	0.896	0.521	1.271	0.	0.	1.001
KINGS	1.108	0.	0.	0.	0.	0.996	0.	1.878	0.	0.	0.958
LAKE	0.	0.	0.	0.	0.	0.905	0.	0.	0.	0.	0.
LASSEN	0.	0.	0.	0.	0.	0.836	0.	0.	0.	0.	0.
LOS ANGELES	1.051	1.255	0.466	0.942	1.518	0.933	0.903	0.978	0.	1.116	0.937
MADERA	0.	0.	0.	6.073	0.	0.645	0.	0.873	0.	0.	0.
MARIN	0.928	0.	0.	1.039	0.	0.838	0.	0.555	0.	0.590	0.710
MARIPOSA	0.	0.	0.	0.	0.	0.774	0.	0.	0.	0.	0.
MENDOCINO	0.	0.	0.	0.	0.	0.937	0.	1.566	0.	0.	0.853
MERCED	1.119	0.	0.	1.363	0.	1.097	0.	2.241	0.	0.	0.880
MODOC	0.	0.	0.	0.	0.	1.115	0.	0.	0.	0.	0.
MONO	0.	0.	0.	0.	0.	2.003	25.516	0.	0.	0.	0.
MONTEREY	0.582	0.749	9.680	1.137	0.	1.087	1.174	1.152	0.	1.122	1.168
NAPA	0.722	0.	0.	1.930	0.	0.943	0.	0.607	0.	0.	1.757
NEVADA	0.	0.	0.	0.	0.	0.712	0.	0.347	0.	0.	0.
ORANGE	1.010	1.234	0.	0.674	1.700	0.556	0.645	0.605	0.	0.572	0.683
PLACER	0.512	0.	0.	3.301	0.	1.021	0.	0.557	0.	0.	1.378
PLUMAS	0.	0.	0.	0.	0.	1.290	0.	0.	0.	0.	0.
RIVERSIDE	1.023	0.126	0.	2.582	0.600	0.712	0.494	0.552	0.	0.478	1.121
SACRAMENTO	0.935	1.685	0.	0.412	0.215	0.981	1.098	0.920	0.	0.274	1.665
SAN BENITO	0.	0.	0.	5.113	0.	0.771	0.	2.111	0.	0.	0.
SAN BERNARDINO	0.606	0.414	0.	2.433	0.394	0.770	0.499	0.815	0.	0.364	0.870
SAN DIEGO	0.918	0.269	0.	0.388	0.557	0.919	1.094	0.503	0.	0.557	1.229
SAN FRANCISCO	1.624	0.343	0.	0.083	0.402	1.739	2.625	0.968	0.	3.502	1.638
SAN JOAQUIN	0.622	1.157	16.101	3.674	0.553	1.097	1.221	2.189	0.	0.431	0.775
SAN LUIS OBISBO	1.191	0.	0.	0.	0.	1.359	0.	0.675	0.	0.	1.079
SAN MATEO	1.042	1.314	0.	0.310	0.770	2.154	0.621	0.521	0.	0.828	0.610
SANTA BARBARA	0.725	0.	0.	0.419	1.576	0.978	0.493	0.671	0.	0.768	1.702
SANTA CLARA	0.904	0.688	1.053	0.820	0.277	0.715	0.453	0.823	0.	0.394	1.035
SANTA CRUZ	0.933	0.	0.	0.751	0.	0.774	0.	1.249	0.	0.	0.649
SHASTA	0.609	0.	0.	0.997	0.	1.300	1.231	1.754	0.	0.	1.075
SIERRA	0.	0.	0.	0.	0.	0.226	0.	0.	0.	0.	0.
SISKIYOU	0.	0.	0.	0.	0.	1.057	0.	2.656	0.	0.	0.785
SOLANO	1.050	0.	0.	1.802	0.	1.351	2.406	1.500	0.	2.702	0.610
SONOMA	0.743	0.	0.	0.431	0.819	0.951	0.972	1.440	0.	0.	0.565
STANISLAUS	0.778	0.753	0.	2.134	0.	0.867	0.618	1.998	0.	0.	0.896
SUTTER	0.	0.	0.	0.	0.	0.630	0.	2.125	0.	0.	0.
TEHAMA	0.	0.	0.	0.	0.	0.851	0.	1.657	0.	0.	0.
TRINITY	0.	0.	0.	0.	0.	1.671	0.	0.	0.	0.	0.
TULARE	2.760	0.	0.	1.274	0.	1.083	0.	1.883	0.	0.	0.861
TUOLUMNE	0.	0.	0.	0.	0.	0.992	0.	0.483	0.	0.	1.370
VENTURA	0.817	0.317	0.	0.681	0.370	0.889	0.915	0.974	0.	0.425	0.916
YOLO	0.799	0.	0.	0.	0.	1.079	0.	2.693	22.104	0.	0.262
YUBA	0.	0.	0.	0.	0.	1.942	0.	0.972	0.	0.	2.386

Table 6.15. (Continued)

COUNTY \ SIC NUMBER	4900	4931	4950	4970	50	5040	5050	52	5200	5300	5400
ALAMEDA	1.095	2.232	1.829	0.	1.155	0.961	0.	0.979	0.828	0.984	0.871
ALPINE	0.	0.	0.	0.	0.	0.	0.	1.700	0.	0.	0.
AMADOR	3.221	0.	0.	0.	0.154	0.	0.	0.886	0.	0.	0.
BUTTE	2.060	4.425	0.	0.	0.666	1.092	0.	1.594	2.833	1.256	1.539
CALAVERAS	5.428	13.127	0.	0.	0.177	0.	0.	1.160	0.	0.	2.054
COLUSA	0.	0.	0.	0.	0.901	0.	0.	1.491	6.371	0.	1.668
CONTRA COSTA	1.881	4.101	2.057	0.	0.575	0.810	0.	1.250	1.231	1.495	1.620
DEL NORTE	0.	0.	0.	0.	0.434	0.	0.	1.015	0.	0.	1.584
EL DORADO	2.794	0.	0.	0.	0.310	0.	0.	1.380	2.069	0.433	1.346
FRESNO	1.447	2.763	1.277	0.	1.308	1.972	3.108	1.237	1.543	1.169	1.185
GLENN	0.	0.	0.	0.	2.176	3.789	0.	1.623	3.696	1.858	1.272
HUMBOLT	1.706	3.956	0.	0.	0.718	1.331	0.	1.051	1.838	1.135	1.072
IMPERIAL	8.625	1.672	2.164	1703.937	1.466	3.465	35.566	1.568	3.362	1.197	1.735
INYO	0.	0.	0.	0.	0.478	0.	0.	1.673	0.	0.965	2.060
KERN	1.400	1.967	0.	0.	1.016	1.697	5.217	1.330	2.462	1.479	1.100
KINGS	1.489	0.	0.	0.	0.422	0.	0.	1.540	4.224	1.010	1.188
LAKE	0.	0.	0.	0.	0.692	0.	0.	1.582	3.638	0.413	2.409
LASSEN	0.	0.	0.	0.	0.288	0.	0.	1.639	0.	0.739	1.587
LOS ANGELES	0.654	0.	0.728	0.	1.117	0.848	0.514	0.855	0.626	0.898	0.900
MADERA	1.589	3.804	0.	0.	0.381	0.	0.	1.492	3.265	0.463	1.278
MARIN	2.758	6.413	0.	0.	0.665	0.844	0.	1.462	1.782	1.032	1.629
MARIPOSA	0.	0.	0.	0.	0.494	0.	0.	1.241	0.	0.	4.873
MENDOCINO	1.974	4.283	0.	0.	0.471	0.607	0.	1.285	1.949	1.566	1.081
MERCED	1.598	3.623	0.	0.	0.670	1.977	0.	1.685	4.016	1.304	1.442
MODOC	0.	0.	0.	0.	1.026	0.	0.	1.269	0.	0.	1.474
MONO	0.	0.	0.	0.	0.061	0.	0.	1.460	0.	0.	0.
MONTEREY	1.814	3.564	0.	0.	0.642	1.922	0.	1.413	1.884	1.242	1.180
NAPA	1.067	2.029	0.	0.	0.389	0.	0.	1.303	2.793	1.095	1.329
NEVADA	0.	0.	0.	0.	0.357	0.	0.	1.556	7.061	0.719	1.103
ORANGE	0.655	0.	0.762	0.	0.552	0.517	0.	1.172	1.194	1.161	1.235
PLACER	2.525	5.389	0.	0.	0.633	0.527	0.	1.463	1.372	0.506	1.528
PLUMAS	6.393	0.	0.	0.	0.260	0.	0.	1.246	3.012	0.	1.372
RIVERSIDE	0.941	0.	0.	13.137	0.785	2.222	0.	1.307	1.441	1.158	1.358
SACRAMENTO	0.631	0.283	0.884	0.	1.133	1.597	0.	1.244	1.316	1.578	1.328
SAN BENITO	0.	0.	0.	0.	0.566	0.	0.	1.030	0.	0.	1.292
SAN BERNARDINO	1.491	0.	0.772	0.	0.711	1.136	1.868	1.349	1.142	1.295	1.599
SAN DIEGO	1.183	0.	0.473	0.	0.619	0.620	0.	1.224	1.383	1.372	1.159
SAN FRANCISCO	1.599	3.564	1.445	0.	1.508	1.274	0.734	0.662	0.307	0.559	0.510
SAN JOAQUIN	1.490	3.031	1.866	0.	1.062	2.235	3.641	1.155	1.963	1.199	1.090
SAN LUIS OBISBO	4.656	0.	0.	0.	0.583	1.408	0.	1.512	2.281	0.878	1.234
SAN MATEO	0.974	1.802	1.940	0.	1.413	1.128	0.	0.954	0.605	0.885	0.863
SANTA BARBARA	1.018	0.594	1.964	0.	0.748	1.632	0.	1.265	1.279	1.214	1.223
SANTA CLARA	0.835	1.311	2.145	0.	0.643	0.494	0.	0.896	0.986	0.976	0.800
SANTA CRUZ	1.457	3.557	0.	0.	0.789	0.767	0.	1.350	1.502	1.141	1.414
SHASTA	2.223	0.	0.	0.	0.875	0.807	0.	1.102	1.909	0.844	1.350
SIERRA	0.	0.	0.	0.	0.239	0.	0.	0.488	0.	0.	0.
SISKIYOU	0.	0.	0.	0.	0.429	0.	0.	1.228	2.278	0.633	1.145
SOLANO	2.670	6.204	0.	0.	0.508	0.319	0.	1.619	1.856	1.329	1.266
SONOMA	2.459	5.734	0.	0.	0.760	1.548	0.	1.375	2.363	1.205	1.336
STANISLAUS	0.535	0.900	0.	0.	0.855	1.214	6.328	1.097	2.138	0.875	1.048
SUTTER	0.	0.	0.	0.	0.778	2.042	0.	1.756	10.127	1.698	1.855
TEHAMA	2.101	5.097	0.	0.	0.215	0.	0.	1.134	2.520	0.512	0.886
TRINITY	0.	0.	0.	0.	0.344	0.	0.	0.791	0.	0.	2.020
TULARE	2.265	0.	0.	0.	1.383	5.272	0.	1.370	4.189	1.048	1.295
TUOLUMNE	2.788	6.153	0.	0.	0.302	0.	0.	1.276	0.	0.499	1.654
VENTURA	1.619	0.	0.	0.	0.726	2.291	0.	1.442	1.895	1.929	1.579
YOLO	2.235	5.297	0.	0.	0.754	0.425	13.335	1.393	3.025	0.411	1.575
YUBA	5.586	13.593	0.	0.	0.652	2.055	0.	1.372	1.867	0.761	1.082

Table 6.15. (Continued)

COUNTY \ SIC NUMBER	5500	5600	5700	5800	5900	60.	6000	6500	70	7010	7200
ALAMEDA	0.984	1.080	1.214	0.795	0.984	0.971	0.785	1.254	0.962	0.586	0.996
ALPINE	0.	0.	0.	0.	0.	0.719	0.	0.	2.606	0.	0.
AMADOR	0.974	0.	0.	1.373	0.536	0.472	0.	0.753	0.420	0.	0.740
BUTTE	1.860	1.472	1.614	1.348	2.541	0.883	1.140	0.831	1.043	0.660	0.858
CALAVERAS	1.540	0.	0.	1.129	1.685	0.817	0.	0.	0.924	4.894	0.677
COLUSA	2.437	0.	0.	1.209	2.306	0.670	0.	0.	0.907	0.	0.
CONTRA COSTA	1.321	1.024	1.273	0.935	1.094	0.787	0.799	1.483	0.895	0.385	1.136
DEL NORTE	1.065	0.	0.	0.931	1.099	0.318	0.	0.	0.467	1.576	0.
EL DORADO	1.992	0.740	0.719	1.799	1.807	1.010	1.732	1.048	1.342	5.802	1.850
FRESNO	1.392	1.322	1.481	1.135	1.545	0.935	0.880	0.566	0.988	1.116	1.297
GLENN	2.073	0.	0.	1.439	2.544	0.434	0.	0.	0.637	0.	1.544
HUMBOLT	1.278	1.192	0.876	0.919	0.967	0.561	0.823	0.574	0.784	1.308	0.901
IMPERIAL	2.182	2.527	1.081	1.175	1.575	0.609	1.064	0.392	0.690	1.995	1.208
INYO	1.820	0.966	0.	2.395	1.628	0.571	0.	0.	0.969	7.528	1.696
KERN	1.562	1.252	1.294	1.293	1.268	0.734	0.931	0.870	0.934	1.390	1.200
KINGS	1.839	1.201	3.145	1.254	2.110	0.610	0.963	0.360	0.762	0.	1.338
LAKE	1.500	0.	1.736	2.064	1.853	1.310	0.	3.139	1.424	1.842	0.866
LASSEN	2.217	1.901	0.	2.131	1.643	1.655	2.745	0.	0.891	3.778	1.262
LOS ANGELES	0.775	0.912	0.814	0.828	0.859	0.971	0.922	0.910	0.058	0.596	0.850
MADERA	2.683	1.027	1.130	1.578	1.770	0.492	0.936	0.305	0.972	1.281	1.865
MARIN	1.676	1.299	1.272	1.500	2.015	1.170	1.376	1.997	1.327	1.085	1.596
MARIPOSA	0.726	0.	0.	0.927	0.	0.430	0.	0.	2.351	25.137	0.
MENDOCINO	1.326	0.843	0.568	1.495	1.227	0.436	0.694	0.313	0.664	2.229	0.788
MERCED	2.063	1.311	1.491	1.816	1.827	1.013	0.980	0.386	0.849	0.703	1.268
MODOC	2.467	0.	0.	1.246	0.	0.783	0.	0.	0.720	0.	0.
MONO	1.429	0.	0.	3.310	0.	0.522	0.	0.	1.318	12.364	0.
MONTEREY	1.648	1.707	1.712	1.490	1.417	0.768	1.023	0.816	1.205	3.978	1.571
NAPA	1.346	0.950	1.067	1.359	1.631	0.573	0.826	0.667	1.303	0.893	1.202
NEVADA	2.603	0.880	1.119	1.250	2.067	0.843	0.	1.529	1.341	6.013	1.433
ORANGE	1.160	1.022	0.921	1.277	0.978	0.879	0.616	1.249	0.902	0.785	1.069
PLACER	2.431	0.455	0.958	1.861	1.702	0.751	1.017	0.850	1.329	4.035	1.231
PLUMAS	1.816	0.	0.	1.355	1.446	0.772	0.	0.	0.472	0.704	0.962
RIVERSIDE	1.620	1.176	1.136	1.356	1.243	0.806	0.788	1.158	1.102	3.536	1.294
SACRAMENTO	1.523	1.262	1.930	1.263	1.126	1.149	0.978	1.274	1.154	1.215	2.170
SAN BENITO	1.744	0.	0.	0.869	1.223	0.469	0.	0.373	0.329	0.	0.713
SAN BERNARDINO	1.406	0.802	1.627	1.541	1.077	0.683	0.795	0.575	1.075	0.695	1.094
SAN DIEGO	1.240	1.004	1.463	1.326	1.097	1.080	0.929	1.380	1.091	2.311	1.308
SAN FRANCISCO	0.421	1.191	0.594	0.789	0.701	2.255	2.921	1.222	1.153	2.011	0.812
SAN JOAQUIN	1.286	0.963	1.357	0.966	1.482	0.720	0.873	0.658	0.945	0.589	1.161
SAN LUIS OBISBO	1.726	1.049	1.459	1.881	2.122	0.733	1.021	0.991	1.145	5.345	1.033
SAN MATEO	0.989	0.870	0.925	1.113	0.904	0.804	0.637	1.142	0.882	0.757	1.098
SANTA BARBARA	1.247	1.553	1.206	1.371	1.383	0.848	0.808	0.794	1.226	2.154	1.469
SANTA CLARA	0.954	0.858	1.003	0.877	0.971	0.655	0.640	0.785	0.925	0.423	0.779
SANTA CRUZ	1.397	0.899	1.197	1.603	1.429	0.669	0.953	0.870	0.964	0.804	1.082
SHASTA	1.690	1.055	0.900	0.937	0.972	0.562	0.762	0.567	1.047	1.480	0.770
SIERRA	0.	0.	0.	0.	0.	0.324	0.	0.	1.017	0.	0.
SISKIYOU	1.775	0.589	0.742	1.635	1.071	0.525	0.898	0.618	0.925	3.173	1.063
SOLANO	2.264	0.980	1.505	2.108	1.200	0.786	1.175	0.633	1.121	0.693	1.638
SONOMA	1.508	1.527	1.612	1.261	1.726	1.168	1.283	0.714	1.009	1.181	1.562
STANISLAUS	1.357	0.989	1.447	0.981	1.357	0.519	0.615	0.556	0.829	0.311	0.996
SUTTER	1.385	0.552	0.915	1.478	1.948	0.680	0.869	0.985	0.816	0.	1.488
TEHAMA	1.854	1.217	0.	1.393	0.884	0.418	0.	0.	0.613	1.243	0.501
TRINITY	0.612	0.	0.	1.218	0.	0.371	0.	0.	0.364	0.	0.
TULARE	1.696	1.161	1.449	1.145	1.715	0.550	0.728	0.395	0.683	0.845	1.004
TUOLUMNE	1.266	0.522	0.	1.499	2.296	0.533	0.	0.902	0.949	2.164	1.526
VENTURA	1.511	0.991	0.994	1.314	1.380	0.720	0.923	0.673	0.941	0.897	1.039
YOLO	1.895	1.221	0.716	1.726	1.488	0.549	0.723	1.043	0.874	1.255	1.002
YUBA	2.417	1.569	0.761	1.387	1.544	0.869	1.000	0.699	0.962	0.936	0.913

Table 6.15. (Concluded)

COUNTY \ SIC NUMBER	7300.	7900.	8000.	8600.	100.	200.	300.
ALAMEDA	1.097	0.930	1.128	1.009	0.247	0.262	0.128
ALPINE	0.	0.	0.	0.	0.	0.	0.
AMADOR	0.	0.	0.502	0.	0.	0.	0.
BUTTE	0.327	0.401	1.989	1.332	4.524	4.765	2.704
CALAVERAS	0.	0.	0.594	0.947	0.	0.	0.
COLUSA	0.	0.	1.502	0.	18.542	14.009	52.252
CONTRA COSTA	0.618	1.132	1.259	1.060	0.442	0.459	0.313
DEL NORTE	0.	0.	0.645	0.	0.	0.	0.
EL DORADO	0.472	2.718	1.208	1.608	1.750	1.727	1.909
FRESNO	0.735	0.810	1.189	1.117	8.185	8.810	3.476
GLENN	0.	0.	0.627	0.509	16.931	17.324	13.909
HUMBOLT	0.315	0.716	1.179	0.927	0.	0.	0.
IMPERIAL	0.357	0.622	0.446	1.034	10.220	11.007	4.295
INYO	0.	0.	0.552	0.	0.	0.	0.
KERN	0.769	1.021	1.048	0.931	6.492	6.896	2.902
KINGS	0.246	0.	1.039	1.266	15.943	16.662	10.490
LAKE	0.	2.760	1.675	4.595	10.496	11.470	3.169
LASSEN	0.	0.	0.969	0.	0.	0.	0.
LOS ANGELES	1.135	0.858	0.933	0.883	0.082	0.074	0.144
MADERA	0.340	1.478	1.144	1.106	18.169	18.722	13.938
MARIN	1.185	1.368	1.378	1.367	0.	0.	0.
MARIPOSA	0.	0.	0.861	0.	0.	0.	0.
MENDOCINO	0.145	0.	0.930	0.398	1.827	1.635	3.252
MERCED	0.343	1.237	1.167	0.921	14.100	10.557	40.447
MODOC	5.411	19.503	18.409	14.527	22.636	16.600	67.543
MONO	0.	0.	0.	0.	0.	0.	0.
MONTEREY	0.627	1.185	1.148	1.040	4.906	5.390	1.267
NAPA	0.355	1.256	2.205	1.123	2.657	2.750	1.948
NEVADA	0.	0.	1.963	0.706	0.	0.	0.
ORANGE	0.856	2.156	0.939	0.721	0.392	0.411	0.249
PLACER	0.371	1.505	2.006	0.778	1.461	1.250	3.025
PLUMAS	0.	0.	0.348	0.	0.	0.	0.
RIVERSIDE	0.609	1.809	1.147	0.939	2.895	2.820	3.439
SACRAMENTO	0.771	0.886	1.320	1.387	0.470	0.443	0.673
SAN BENITO	0.	0.	0.391	0.	12.060	12.401	9.450
SAN BERNARDINO	0.726	1.360	1.206	1.103	0.119	0.826	3.919
SAN DIEGO	0.858	0.962	1.039	1.253	0.706	0.691	0.816
SAN FRANCISCO	1.581	0.785	0.759	1.800	0.	0.	0.
SAN JOAQUIN	0.547	1.054	1.118	0.999	4.801	4.814	4.683
SAN LUIS OBISBO	0.215	0.842	1.245	1.652	3.151	2.869	5.232
SAN MATEO	1.042	1.401	0.691	0.641	0.284	0.314	0.056
SANTA BARBARA	1.202	1.084	1.210	1.043	1.849	1.925	1.270
SANTA CLARA	1.021	0.659	0.990	0.772	0.378	0.385	0.324
SANTA CRUZ	0.521	1.489	1.558	0.781	3.230	3.602	0.438
SHASTA	0.304	1.762	1.544	1.908	1.528	1.321	3.066
SIERRA	0.	0.	0.	0.	0.	0.	0.
SISKIYOU	0.	0.	1.669	0.297	3.106	2.649	6.496
SOLANO	0.674	1.098	1.687	1.641	1.968	2.055	1.314
SONOMA	0.481	1.002	1.459	0.875	2.641	2.261	5.459
STANISLAUS	0.449	0.590	1.311	0.987	4.075	2.490	15.879
SUTTER	0.414	0.	1.022	0.674	10.033	11.098	2.033
TEHAMA	0.	0.	0.946	0.728	6.614	6.144	10.083
TRINITY	0.	0.	0.	0.	0.	0.	0.
TULARE	0.366	0.589	0.776	1.017	17.466	18.883	6.796
TUOLUMNE	0.	1.038	1.313	1.471	0.	0.	0.
VENTURA	0.882	0.777	1.069	1.177	3.822	3.966	2.722
YOLO	0.377	0.748	1.252	1.336	4.706	5.211	0.909
YUBA	0.	0.	1.790	1.004	3.756	3.866	2.911

Table 6.16. Coefficients of localization for California agricultural activities in 1972.

Activity	Coefficient of localization
All agricultural activities	0.6621
All crop related agriculture	0.6704
Beef cattle and livestock	0.6581

Table 6.17. California County indices of diversification for 1972.

COUNTY	RID
ALAMEDA	0.5343
ALPINE	0.8859
AMADOR	0.6329
BUTTE	0.5224
CALAVERAS	0.5470
COLUSA	0.6222
CONTRA COSTA	0.5532
DEL NORTE	0.7274
EL DORADO	0.5158
FRESNO	0.5051
GLENN	0.6784
HUMBOLT	0.6556
IMPERIAL	0.5380
INYO	0.6228
KERN	0.4439
KINGS	0.6640
LAKE	0.6062
LASSEN	0.6641
LOS ANGELES	0.2600
MADERA	0.6929
MARIN	0.5829
MARIPOSA	0.7158
MENDOCINO	0.6064
MERCED	0.6253
MODOC	0.6630
MONO	0.6498
MONTEREY	0.5019
NAPA	0.5510
NEVADA	0.6333
ORANGE	0.5971
PLACER	0.5196
PLUMAS	0.6966
RIVERSIDE	0.4896
SACRAMENTO	0.4587
SAN BENITO	0.6113
SAN BERNARDINO	0.5742
SAN DIEGO	0.5227
SAN FRANCISCO	0.4852
SAN JOAQUIN	0.4711
SAN LUIS OBISBO	0.4977
SAN MATEO	0.4730
SANTA BARBARA	0.4806
SANTA CLARA	0.6248
SANTA CRUZ	0.5167
SHASTA	0.4885
SIERRA	0.8118
SISKIYOU	0.5533
SOLANO	0.5344
SONOMA	0.4722
STANISLAUS	0.5259
SUTTER	0.5816
TEHAMA	0.6616
TRINITY	0.6936
TULARE	0.6206
TUOLUMNE	0.5309
VENTURA	0.4479
YOLO	0.5003
YUBA	0.4652

Table 6.18. SIC numbers and associated industry titles for Imperial County characterization.[1]

SIC no.	Digit level	Industry title
07	1	Agricultural service, forestry and fishing
0700	2[a]	Agricultural services and hunting
0800	2	Forestry
0900	2	Fishing
10	1	Mining
1000	2	Metal mining
1300	2	Oil and gas extraction
1381	4	Drilling wells
1382	4	Exploration services
15	1	Contract construction
1500	2	General building
1600	2	Heavy construction
1700	2	Special trade construction
19	1	Manufacturing
2000	2	Food and kindred products
2010	3	Meat products
2030	3	Canned, Cured, and frozen products
2040	3	Grain mill products
2060	3	Sugar
2090	3	Miscellaneous food products
2200	2	Textile mill products
2400	2	Lumber and wood
2500	2	Furniture and fixtures
2600	2	Paper and allied products
2700	2	Printing and publishing
2800	2	Chemical and allied
2870	3	Agricultural fertilizer
2900	2	Petroleum and coal
3000	2	Rubber and plastics
3200	2	Stone, clay, glass
3300	2	Primary metals
3400	2	Fabricated metals
3520	3	Farm machinery
3530	3	Construction machinery
3600	2	Electrical machinery
3700	2	Transportation equipment
3800	2	Instruments and related
3900	2	Miscellaneous manufacturing
40	1	Transportation and public utilities

[a]Two-digit-level SIC's are subsets of the previous one digit SIC's; three-digit SIC's are subsets of two-digit SIC's and four-digit SIC's are subsets of three-digit SIC's.

Table 6.18. (Continued)

SIC no.	Digit level	Industry title	SIC no.	Digit level	Industry title
4100	2	Local and interurban transportation	5400	2	Food
			5500	2	Auto
4150	3	School busses			
			5600	2	Clothes
4200	2	Trucking and warehousing	5700	2	Furniture
4221	4	Farm product warehousing	5800	2	Eating and drinking places
4500	2	Transport by air	5900	2	Miscellaneous retail
4600	2	Pipeline transport	60	1	Finance, insurance and real estate
4700	2	Transportation service			
			6000	2	Banking
4800	2	Communication and utilities	6500	2	Real estate
4900	2	Electricity, gas and sanitary services	70	1	Services
			7010	3	Hotel and motel
4931	4	Electricity and other services	7030	3	Trailer park and recreational camps
4940	3	Water supply			
			7200	2	Personal services
4950	3	Sanitary			
			7300	2	Miscellaneous business services
4970	3	Irrigation services			
50	1	Wholesale	7512	4	Car rental and leasing
5010	3	Auto and related	7800	2	Motion picture
5040	3	Groceries and related	7900	2	Amusement and recreational services
5050	3	Farm Products (raw)			
			7940	3	Miscellaneous amusement and recreational services
52	1	Retail			
5200	2	Building and farm equipment	8000	2	Medical and health
			8060	3	Hospitals
5300	2	General store			
			8200	2	Education services

Table 6.18. (Concluded)

SIC no.	Digit level	Industry title	SIC no.	Digit level	Industry title
8600	2	Nonprofit organization	200[b]	3	Crop related agriculture
100[b]	2	All agriculture	300[b]		Beef cattle and livestock

[b]Data not from County Business Pattern SIC information. Provided by Dr. Lofting.

Table 6.19. Imperial County sectors of major state importance.

SIC number	Sector name	Location quotient
4970	Irrigation services	1703.937
4221	Farm product warehousing	66.952
5050	Farm product (raw) wholesaling	35.566
2060	Sugar manufacturing	14.784
2870	Agricultural fertilizer manufacturing	14.574
2040	Grain mill products	11.028
200	Crop related agriculture	11.007
100	All agriculture	10.220
700	Agricultural support	10.174
4900	Electricity, gas, and sanitary services	8.625
300	Beef, cattle, and livestock	4.295
3200	Stone, clay and glass manufacturing	3.731
5040	Groceries and related wholesale	3.465
5200	Building and farm equipment, wholesale	3.362

Table 6.20. Comparison of selected sector location quotients for Kern, Fresno, and Imperial Counties.

SIC number	Imperial County	Fresno County	Kern County
4970	1703.937	0	0
4221	66.952	13.755	0
5050	35.566	3.108	5.217
2060	14.784	4.429	0
2870	14.564	5.850	0
2040	11.028	1.103	16.756
200	11.007	8.810	6.896
100	10.220	8.185	6.492
700	10.174	1.818	2.242
4900	8.625	1.447	1.400
300	4.295	3.476	2.902
3200	3.731	1.163	1.472
5040	3.465	3.789	1.697
5200	3.362	3.696	2.462

sections, we will now provide a cursory description of the spatial variations of economic activity within the county. Of particular interest to this study is the distribution of activity with respect to the four principal Known Geothermal Resource Areas (KGRAs) in the Imperial Valley. Figure 6.4 shows the location of Imperial Valley's 67 active and inactive feed lots mapped against KGRA boundaries. If future county ordinances for geothermal powerplant siting were to require at least a 1-mi separation between a powerplant and feed lot, each feed lot located within a KGRA will eliminate almost 5 mi^2 (3100 acres) of potential area for plant siting.

Sector Intracounty Distribution

Industry. Most of the county's industry is centered in slightly over 700 acres of industrially zoned land in the city of El Centro, along the short axis between El Centro and Imperial and particularly the area around the commercial airport and county fair grounds. A secondary center exists in Calexico. Minimal industrial activity

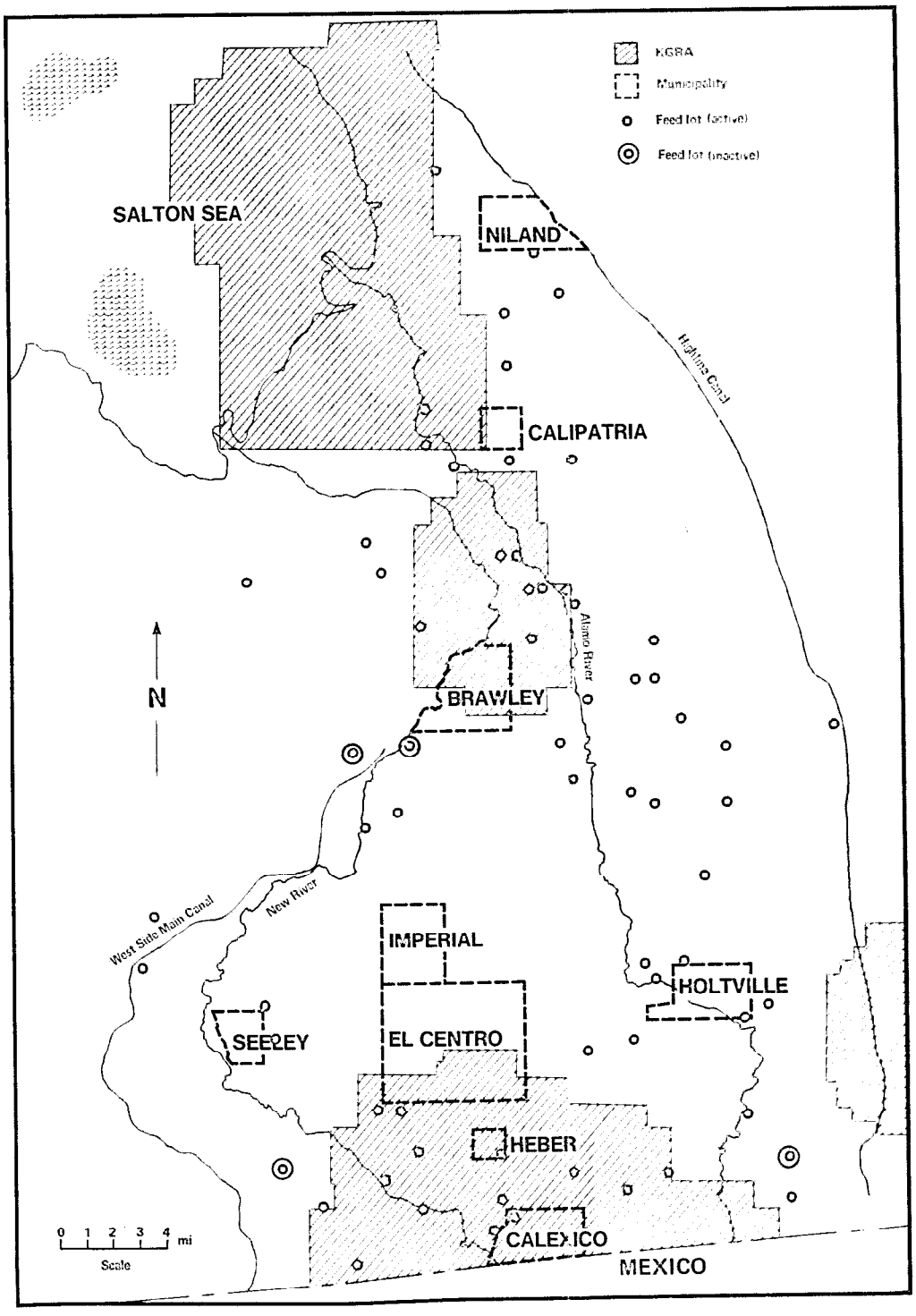


Fig. 6.4. Imperial Valley feed lot operations mapped against KGRAs.

exists in Imperial Valley outside these areas. County land use plans for the future call for development of industrial centers north of Seeley in the Mesquite Lake area and just east of Niland (see subsection 7.4). In addition to the present spatial concentration of industrial activity, several individual sectors for the county are concentrated in one or two major activities (i.e. agricultural fertilizers, sugar production, federal government, Anza meat packers, U.S. Gypsum, stone and clay manufacturing, mining, etc.).

Commerce. This category includes wholesale, retail, and service sectors. Again, these activities, especially the more specialized individual activities, are centered in El Centro. Commercial activities are, however, slightly more diversified than industrial. Brawley serves as a general retail center for the northern end of the Valley, and Calexico with one of the highest retail sales to population ratios for a California city is an extensive and rapidly growing retail center serving both the southern sections of the Imperial Valley and Mexicali. In 1974, El Centro recorded 51.6% of the county retail sales (see Table 6.21) while Calexico recorded 37.9%. Brawley was a distant third with over 7% of the total county retail sales.

Recreation. Primary recreational activities within Imperial County are centered on sand dune related activities (especially in The Dunes Recreational Area) and principally on dune buggy activities. Secondary to this class of recreation is water related activities. Water related recreation within the county is fairly evenly split between the Colorado River and the Salton Sea based on the number of permanently moored vessels, available moorings, estimated recreator days, and on county staff estimates. Several small freshwater lakes along the New and Alamo Rivers comprise the rest of the county water related activity.

Estimates of the total annual recreational value of the Salton Sea have been set at $11,000,000 by the U.S. Department of the Interior.[21] Previous estimates of Salton Sea recreational use and economic value for 1967 made by the State Department of Fish and Game[22] are shown in Table 6.21. As of 1970, Arnett, director of the California Department of Fish and Game, estimated that the 1967 use figure approximated capacity use levels. In both the 1973 U.S. Department of Interior and the California Department of Fish and Game studies, the two sites on the Salton Sea receiving heaviest recreational use were in Riverside County. This dominance of Riverside County over

Imperial County in recreational use of the Salton Sea may be a partial explanation of the view expressed to us during interviews held with numerous Imperial County staff officers on March 9 and 10, 1976, that Imperial County does not consider the Salton Sea as a major recreational or a significant economic resource.

El Centro Economy

Data have been gathered on aspects of the El Centro city economy; some of these statistics are listed in Table 6.22. Comparison of this data to county data shows the dominance of El Centro within the county economy and general growth patterns of both the city and county over the past 5 years.

Table 6.21. Recreational use of the Salton Sea and resultant economic benefit in 1967.[22]

Activity	Recreation days	Total economic benefit, $
Fishing	356,000	719,200
Hunting	42,000	103,000
General recreation[a]	1,100,100	1,200,300
Total	1,498,100	2,022,500

[a]Includes boating, swimming, water skiing, camping, and picnicking.

Table 6.22. El Centro: Indicators of economic activity.[a]

Persons employed	El Centro total		% County total
Manufacturing	1326		89.2
Government (city, county)	1067		38.18
Miscellaneous economic indicators	1970	1972	1974
Building permits	2,627,476	5,332,417	3,126,544
Bank deposits	$95,746,424	$143,743,034	$152,737,345
Total retail sales	$67,769,000	$ 79,422,000	$100,706,000
Automobile registrations	55,033	59,890	65,672

[a]From El Centro Chamber of Commerce (1974).[20]

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Section 7
County Fiscal Characterization

Kendall Haven

7.1 FISCAL BUDGET ANALYSIS

This basic county fiscal characterization is based on budget items as listed in the 1975-1976 County Final Budget, Schedule 5, Adopted Expenditures,[1] and on 1974 estimated county populations. The Imperial County budget and per capita county budget are shown in Table 7.1. Comparisons with budgets for other selected counties for 1975-1976 are shown in Tables 7.2 and 7.3. Table 7.2 shows location quotients for each budget item and Table 7.3 shows budget items as a percentage of total county budgets. State budget and budget item totals for the calculation of location quotients were not taken from the state budget. State and county budgetary functions are very different; there is no direct relationship between county and state expenditure. Rather, state totals as used here represent the sum of all county budgets and budget items. Finally, per capita budgets for selected counties are listed in Table 7.4, and comparative location quotients for each per capita budget item are shown in Table 7.5. Zero budget item entries such as fire protection or debt service indicate that no money was appropriated under that given line item title. Comparing the data in Tables 7.2 and 7.3 (total budget data) with that in Tables 7.4 and 7.5 (per capita budget data) gives a relatively complete picture of Imperial County fiscal spending patterns.

Based on the total budget data of Tables 7.2 and 7.3 and disregarding plant acquisition, Imperial County appears to be fairly typical in its relative fiscal spending habits with the exceptions of health and sanitation and public assistance. Relative Imperial County expenses are substantially below the 10-county norm for both health and public assistance. However, per capita figures indicate Imperial County is very near the state normative value for public assistance, but is slightly below average for health. Sanitation spending, the other subcategory under health and sanitation, is unusually high for Imperial County and, at $5.69 per person, is far larger than for any other county on a per capita basis. Imperial County also spent significantly more in fiscal year 1975-1976 for public ways than any other county analyzed on a per capita basis. However this budget category

Table 7.1. Imperial County budget for 1975-76.[1]

Budget item	County total budget	County per capita budget
Total Budget	$38,722,551	$519.82
General government	11,422,185	153.33
Plant acquisition	7,482,968	100.45
Public protection	7,861,455	105.53
Courts	1,652,959	22.19
Police	1,715,332	23.03
Fire	746,850	10.03
Health and sanitation	2,532,347	34.00
Health	2,112,101	28.35
Sanitation	420,246	5.64
Public assistance	11,641,922	156.28
Education	410,064	5.15
Public ways	3,742,385	50.24
Recreation	313,438	4.45
Debt	0	0.00
Reserve and contingency	780,755	10.48
General government less plant acquisition	3,939,217	52.88

is related as much to area as it is to population, and its high value reflects the extensive county road system in the Imperial Valley. As mentioned above, per capita Imperial County public assistance expenditure is not low. If Mexican green card labor acted as an effective buffer for county employment and unemployment, certain portions of county spending in this category would be expected to be low for Imperial County.

County revenues for FY 1975-1976 are listed in Table 7.6. The relative distribution of these revenues is assumed representative of future fiscal years, and these revenue percentages may, on this basis, be used for future analytical purposes. Almost 50% of county revenue comes from state and federal agencies. Of the county generated funds, 37% came from current property tax and 35% from carryover funds. Of the

Table 7.2. Comparative county budget location quotients for selected budget categories.

COUNTY	GEN. GOVT.	(PLANT ACQUI)*	PUBLIC PROTECT	(COURTS)	(POLICE)	(FIRE)	HEALTH + SAN.	(HEALTH)	(SAN)	PUBLIC ASSIST	EDUCATION
CONTRA COSTA	0.408	0.369	1.145	1.179	0.996	0.	1.102	1.123	0.443	1.148	2.220
FRESNO	0.797	2.804	1.054	1.035	1.102	0.	0.586	0.596	0.278	1.134	2.229
IMPERIAL	1.418	8.258	1.255	0.964	1.035	2.029	0.444	0.382	2.384	0.776	0.995
KERN	0.610	2.373	1.549	0.816	1.301	8.860	1.088	1.085	1.171	0.822	1.417
LOS ANGELES	1.087	0.428	0.865	0.907	0.924	0.900	1.101	1.110	0.820	0.995	0.774
NAPA	0.917	2.850	1.235	0.834	1.243	2.280	0.581	0.591	0.127	0.666	3.167
RIVERSIDE	0.905	1.295	1.355	1.007	1.487	1.404	0.534	0.546	1.780	1.069	0.945
SACRAMENTO	0.626	0.937	1.320	1.398	1.472	0.	0.981	1.012	0.018	1.013	1.127
SAN DIEGO	1.254	2.207	1.100	1.289	1.149	0.	0.518	0.433	3.184	1.036	0.825
SAN MATEO	0.715	3.323	1.404	1.228	0.285	0.506	1.355	1.393	0.164	0.850	1.765

COUNTY	PUBLIC WAYS	RECREATION	DEBT	CONTINGENCY & RESERVE	GEN GOVT - PLANT ACQUI.
CONTRA COSTA	1.573	0.032	0.878	1.513	0.413
FRESNO	1.694	0.507	0.	1.839	0.543
IMPERIAL	1.953	0.603	0.	1.627	0.551
KERN	1.537	1.915	1.167	1.824	0.386
LOS ANGELES	0.851	1.146	0.746	0.619	1.170
NAPA	2.241	0.209	3.838	8.785	0.672
RIVERSIDE	1.260	0.469	0.384	0.975	0.856
SACRAMENTO	1.000	0.988	2.549	3.315	0.586
SAN DIEGO	0.991	0.697	2.617	0.756	1.133
SAN MATEO	0.993	0.810	0.300	1.228	0.384

* CATEGORIES IN PARENTHES ARE SUB-CATEGORIES OF THE CLOSEST PREVIOUS CATEGORY NOT IN PARENTHESES.

Table 7.3. Comparative percentage composition of selected county budgets for 1975-76.

County	% of Total budget							
	General government	(Plant acquisition)[a]	Public protection	(Courts)	(Police)	(Fire)	Health and sanitation	(Health)
Contra Costa	8.483	0.863	18.522	5.220	4.261	0	16.222	16.020
Fresno	16.591	6.562	17.065	4.584	4.717	0	8.635	8.508
Imperial	29.498	19.325	20.302	4.269	4.430	1.929	6.540	5.454
Kern	12.685	5.552	25.067	3.614	5.569	8.424	16.022	15.484
Los Angeles	22.610	1.002	14.002	4.019	3.952	0.855	16.212	15.839
Napa	19.086	6.670	19.980	3.695	5.319	2.168	8.554	8.436
Riverside	18.836	3.029	21.935	4.460	6.361	1.335	8.595	7.785
Sacramento	13.018	2.193	21.361	6.193	6.298	0	14.450	14.442
San Diego	26.093	5.165	17.805	5.710	4.918	0	7.635	6.186
San Mateo	14.870	7.775	22.724	5.438	1.218	0.481	19.947	19.872

County	(Sanitation)	Public assistance	Education	Public ways	Recreation	Debt	Reserve and contingency	General government less plant acquisition
Contra Costa	0.202	44.498	2.362	7.783	0.045	0.210	1.875	7.620
Fresno	0.126	43.946	2.372	8.383	0.720	0	2.279	10.029
Imperial	1.085	30.065	1.059	9.665	0.856	0	2.016	10.173
Kern	0.533	31.849	1.508	7.609	2.718	0.279	2.260	7.133
Los Angeles	0.373	38.574	0.823	4.210	1.627	0.178	0.767	21.607
Napa	0.058	25.819	3.370	11.093	0.296	0.916	10.886	12.413
Riverside	0.810	41.426	1.006	6.236	0.666	0.092	1.208	15.807
Sacramento	0.008	39.260	1.200	4.951	1.402	0.608	4.107	10.825
San Diego	1.449	40.135	0.878	4.903	0.989	0.624	0.937	20.928
San Mateo	0.075	32.931	1.879	4.914	1.150	0.072	1.521	7.096

Table 7.4. County fiscal per capita budgets.

COUNTY	TOTAL BUDGET	GEN. GOVT.	(PLANT ACQUI)*	PUBLIC PROTECT	(COURTS)	(POLICE)	(FIRE)	HEALTH + SAN.	(HEALTH)	(SAN)	PUBLIC ASSIST
CONTRA COSTA	372.06	31.56	3.21	68.91	19.42	15.85	0.	60.36	59.60	0.75	165.56
FRESNO	404.55	67.12	26.55	69.04	18.54	19.08	0.	34.93	34.42	0.51	177.79
IMPERIAL	519.82	153.33	100.45	105.53	22.19	23.03	10.03	34.00	28.35	5.64	156.28
KERN	490.66	62.24	27.24	122.99	17.73	27.32	41.33	78.62	75.97	2.62	156.27
LOS ANGELES	404.96	91.56	4.06	56.70	16.27	16.00	3.46	65.65	64.14	1.51	156.21
NAPA	313.02	59.74	20.88	62.54	11.57	16.65	6.79	26.78	26.41	0.18	80.82
RIVERSIDE	350.91	66.10	10.63	76.97	15.65	22.32	4.68	30.16	27.32	2.84	145.37
SACRAMENTO	385.09	50.13	8.45	82.26	23.85	24.25	0.	55.65	55.61	0.03	151.19
SAN DIEGO	314.36	82.03	16.24	55.97	17.95	15.46	0.	24.00	19.45	4.56	126.17
SAN MATEO	279.78	41.60	21.75	63.58	15.21	3.41	1.35	55.81	55.60	0.21	92.13

COUNTY	EDUCATION	PUBLIC WAYS	RECREATION	DEBT	CONTINGENCY & RESERVE	GEN.GOVT-PLANT ACQUI.
CONTRA COSTA	8.79	28.96	0.17	0.78	6.98	28.35
FRESNO	9.60	33.91	2.91	0.	9.22	40.57
IMPERIAL	5.51	50.24	4.45	0.	10.48	52.88
KERN	7.40	37.34	13.34	1.37	11.09	35.00
LOS ANGELES	3.33	17.05	6.59	0.72	3.10	87.50
NAPA	10.55	34.72	0.93	2.87	34.07	38.86
RIVERSIDE	3.53	21.88	2.34	0.32	4.24	55.47
SACRAMENTO	4.62	19.07	5.40	2.34	15.82	41.68
SAN DIEGO	2.76	15.41	3.11	1.96	2.95	65.79
SAN MATEO	5.26	13.75	3.22	0.20	4.26	19.85

* CATEGORIES IN PARENTHESES ARE SUB-CATEGORIES OF THE CLOSEST PREVIOUS CATEGORY NOT IN PARENTHESES.

Table 7.5. County per capita budget location quotients.

COUNTY	GEN. GOVT.	(PLANT ACQUI)*	PUBLIC PROTECT	(COURTS)	(POLICE)	(FIRE)	HEALTH + SAN.	(HEALTH)	(SAN)	PUBLIC ASSIST	EDUCATION
CONTRA COSTA	0.683	0.618	1.916	1.973	1.667	0.	1.844	1.879	0.742	1.922	3.716
FRESNO	1.451	5.104	1.919	1.884	2.006	0.	1.067	1.085	0.506	2.064	4.057
IMPERIAL	3.316	19.314	2.934	2.254	2.421	4.744	1.039	0.894	5.576	1.814	2.328
KERN	1.346	5.238	3.419	1.801	2.873	19.559	2.402	2.395	2.586	1.814	3.129
LOS ANGELES	1.980	0.781	1.576	1.653	1.683	1.639	2.006	2.022	1.494	1.813	1.409
NAPA	1.292	4.014	1.739	1.175	1.751	3.211	0.818	0.833	0.179	0.938	4.460
RIVERSIDE	1.429	2.044	2.140	1.590	2.347	2.217	0.922	0.861	2.810	1.688	1.493
SACRAMENTO	1.084	1.624	2.287	2.422	2.550	0.	1.700	1.753	0.031	1.755	1.953
SAN DIEGO	1.774	3.122	1.556	1.823	1.625	0.	0.733	0.613	4.503	1.465	1.167
SAN MATEO	0.900	4.182	1.768	1.545	0.358	0.637	1.705	1.753	0.207	1.070	2.222

COUNTY	PUBLIC WAYS	RECREATION	DEBT	CONTINGENCY & RESERVE	GEN.GOVT-PLANT ACQUI.
CONTRA COSTA	2.632	0.053	1.469	2.533	0.691
FRESNO	3.083	0.923	0.	3.348	0.989
IMPERIAL	4.567	1.410	0.	3.805	1.288
KERN	3.394	4.228	2.577	4.026	0.853
LOS ANGELES	1.550	2.089	1.358	1.127	2.132
NAPA	3.156	0.294	5.405	12.372	0.947
RIVERSIDE	1.989	0.741	0.607	1.539	1.352
SACRAMENTO	1.733	1.712	4.416	5.743	1.016
SAN DIEGO	1.401	0.986	3.701	1.070	1.603
SAN MATEO	1.250	1.020	0.378	1.545	0.484

* CATEGORIES IN PARENTHESES ARE SUB-CATEGORIES OF THE CLOSEST PREVIOUS CATEGORY NOT IN PARENTHESES.

Table 7.6. Imperial County revenues for FY 1975-76.[1]

Category	Subcategory	Subcategory total	Category total	% Total revenue
Current property tax			$7,164,567	18.50
Other taxes			1,314,600	3.39
	Other property tax	$ 225,100		
	Sales and use tax	720,000		
	In lieu livestock tax	200,000		
	Miscellaneous	139,000		
Licenses and permits			104,180	0.27
Fines, forfeitures, and penalties			638,095	1.65
Use of money and property			1,031,120	2.66
State government			9,786,623	25.27
	Highway users tax	1,463,430		
	Gas tax	316,736		
	Transportation fund	193,717		
	In lieu taxes	579,100		
	Welfare	1,934,500		
	Property tax deductions	754,830		
	Mental health	630,000		
	Aid for construction	2,903,576		
	Parks and recreation	237,035		
	Other	713,699		
Federal government			9,578,833	24.74
	Welfare	1,025,000		
	Aid for children	2,052,000		
	Aid for planning	$1,516,900		
	Geothermal project	341,600		
	Other	4,633,333		
Charges for current services			$2,138,856	5.52
Other			99,180	0.26
Carry-over			6,866,498	17.73
Total			$38,722,551	100.00

remaining 27%, 11% came from charges for current services, 5% from use of money and property, 7% from other taxes, and the remaining 4+% from miscellaneous sources.

7.2 COUNTY TAX STRUCTURE

There are four basic elements that comprise the total property tax rate for any given location: county, municipal, school, and special district taxes. The impact of special district taxes on any given location is highly variable within Imperial County, while the other three are fairly uniform. For any nonmunicipal area, the 1975-1976 county wide tax rate is 2.9285 (per $100 of assessed value).[3] County wide tax rates within municipalities vary from a low of 2.7649 up to 2.9285, while municipal taxes vary from a low of

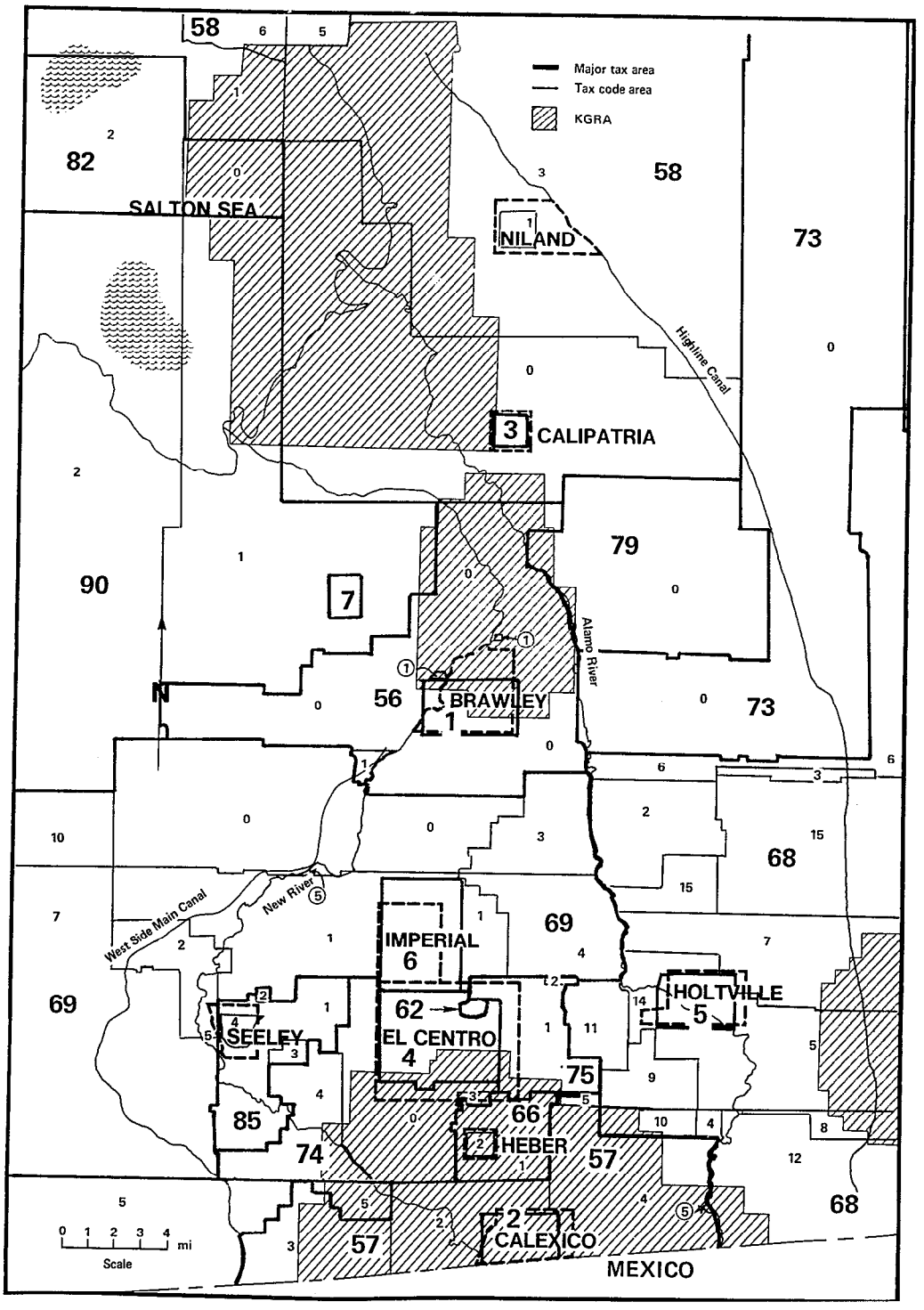

Fig. 7.1. Imperial County tax code areas mapped against KGRAs.

2.3200 in Calexico to a high of 4.1166 in Calipatria. School tax rates vary from 5.3625 to 7.3251 and, finally, cumulative special district taxes for the county tax code areas vary from 0 up to 11.9444. Figure 7.1 shows the location of tax code areas with respect to the major

KGRAs. This relationship is important since school, special districts, and, to a lesser extent, county tax revenues (and thus tax rates) will be significantly affected by geothermal development within their boundaries. Table 7.7 compares tax rates for the past 3 years for all tax code areas lying over, or adjacent to, major KGRAs. Previously anticipated reductions in the FY 77 county wide tax rate now appear unlikely,[6] and the tax rates reported here for FY 75-76 will remain essentially unchanged for at least the immediate future. Currently, only 21.9% of the county's annual revenue is derived from in-county taxes (see Table 7.6), however this represents 44% of the FY 75-76 revenue that can be manipulated by the county. In addition, taxes are the easiest revenue item for the county to manipulate. Thus, while county tax rates are projected as near constant for the next 1 to 2 years, more generally they are subject to substantial change since the county in an attempt to control total county revenue tries to adjust to changing state and federal funding levels.

Analysis of the data in Table 7.7 reveals several interesting trends in Imperial County. With the exception of the general tax area 57-xxx, every tax code area shown in Table 7.7 either sustained a net tax rate decrease over the period shown or at least had a rate reduction for one of the years shown. This indicates a willingness on the part of local officials to translate increased assessed value and increased state and federal income into lower tax rates rather than into increased local government spending. Over the 3-yr period shown, the largest total rate increase has been in tax code area 66-002 (Heber) with a 30.5% increase. The second largest was 57-002 (Calexico) with an 18.8% increase. Of the 37 tax code areas listed, 17 actually showed net reduced rates over this 3-yr period.

Geothermal development could affect these tax rates on several levels. First, county and state taxes associated with geothermal developmental activity could be translated into either increased county spending for various services or into lower tax rates throughout the county. Either of these actions would affect all county citizens equally. Second, local and special districts co-located with geothermal development activity will accrue revenue from this development and, like the county, could either increase the level of services provided (increasing spending) or reduce local tax rates. School tax rates, under SB-90, could decline with revenues from geothermal development. This

Table 7.7. Tax rate for tax code areas adjacent to major KGRAs (1973-1976).[3,4,5]

Tax code	Area	KGRA	Total tax rates 1973-4	1974-5	1975-6
01-001	Brawley	Brawley	11.8437	12.5118	12.3549
01-002	Brawley	Brawley	11.8437	12.5118	12.3549
02-000	Calexico	Heber	10.6753	11.4181	11.4918
02-001	Calexico	Heber	10.6753	11.4181	11.4918
03-000	Calipatria	Salton Sea	14.9053	13.3301	13.5049
04-000	El Centro	Heber	12.5290	12.3289	12.0799
04-001	El Centro	Heber	12.5290	12.3289	12.0799
04-002	El Centro	Heber	—	12.3289	12.0799
56-000	Brawley	Brawley	8.4205	9.1070	8.9125
57-001	Calexico	Heber	7.8246	9.2622	9.0933
57-002	Calexico	Heber	7.8246	9.2622	9.2933
57-003	Calexico	Heber	7.8246	9.2622	9.2933
57-004	Calexico	Heber	7.8246	9.2622	9.2933
57-005	Calexico	Heber	7.9014	9.3659	9.2484
58-000	Calipatria	Salton Sea	9.9787	9.2135	9.3883
58-001	Niland	Salton Sea	9.7215	9.0684	9.3155
58-003	Calipatria-Niland	Salton Sea	9.6267	8.9536	9.1889
58-005	Bombay Beach	Salton Sea	11.2085	—	10.8299
58-006	Bombay Beach	Salton Sea	11.2085	10.2014	10.9565
66-001	Heber	Heber	9.2960	9.7837	9.4148
66-002	Heber	Heber	10.0239	13.5154	13.0811
68-005	Holtville	East Mesa	9.7655	8.5033	9.6839
68-007	Pine Union	East Mesa	9.6056	8.3663	9.5341
68-008	Holtville	East Mesa	9.6887	8.3996	9.5288
68-009	Alamitos	Heber	9.5573	8.3214	9.5341
68-010	Alamitos	Heber	9.4805	8.2177	9.5790
68-012	Verde	East Mesa/ Heber	9.4805	8.2177	9.5790
68-013	Verde	Heber	9.4805	8.2177	9.5790
74-000	McCabe	Heber	9.1324	8.9690	9.3009
74-003	McCabe-Heber	Heber	9.0497	8.8940	9.2427

Table 7.7. (Concluded)

Tax code	Area	KGRA	Total tax rate 1973-4	1974-5	1975-6
74-004	McCabe	Heber	9.0497	8.8940	9.2427
74-005	McCabe-Centinel	Heber	8.9729	8.7903	9.2876
75-001	Meadows	Heber	10.1443	9.7445	10.2521
79-000	Mulberry	Brawley	9.5324	9.0425	9.2122
82-000	Oasis	Salton Sea	10.2188	9.7055	9.7809
82-002	Oasis	Salton Sea	10.1240	9.5907	9.6543
90-001	Westmorland	Brawley	9.0925	9.2033	9.0149

Summary:	KGRA	Number of adjacent tax codes
	Salton Sea	8
	Brawley	5
	Heber	21
	East Mesa	4

represents a local benefit that would accrue only to those in the areas surrounding the development site. Finally, geothermal development will bring new jobs and population into the county. This new population will represent a demand for increased local and county governmental services. If these new people do not choose to live in the tax code areas immediately surrounding associated development sites, their demand for services will not be realized by the same local, school, and special districts that will accrue geothermal tax benefits. For example, if workers from a geothermal power plant in the Brawley KGRA decided to live in El Centro, the El Centro school districts would feel the increased demand for services while Brawley Elementary and Brawley Union High School Districts would receive the additional tax monies from the development. Finally, the number of tax code areas potentially affected by development on each KGRA is listed in the Summary section of Table 7.7. Development in the Heber KGRA will have the most diverse impact while development in other major KGRAs

will have a much more spatially limited impact. Only one tax-code area, 68-012 is positioned to receive tax benefits from more than one KGRA.

7.3 COUNTY SCHOOL DISTRICTS AND BUDGETS

There are 17 school districts in Imperial county. Of these, nine are elementary school districts with two superimposed high school districts, five are unified school districts, and the last is the Imperial Community College district, which is county wide. The boundaries of these various districts are shown in Fig. 7.2. for the Imperial Valley and in Fig. 7.3 are mapped against KGRA boundaries. This relationship will be extremely important to property owners for state school reveune limits will increase the probability that geothermal tax revenues to school districts will be translated into lower tax rates.

Selected fiscal data from school districts in Imperial County are presented in Table 7.8. Annual expenditures per average daily attendance (ADA) were around $1000 for elementary schools with the exception of Magnolia Union ($2067.46) and Mulberry ($1578.57). However, the elementary school tax rate for both of these districts was low, with Magnolia Union having the lowest tax rate (1.9656) of any of the 16 basic school districts. The cause of this apparent anomaly has not yet been determined. Annual expenditure per ADA was only marginally higher for high school districts ($1256) than for elementary schools ($1212). Unified districts, however, spend considerably more per year per ADA with an average of $1343 per ADA per year than either of the other two types of school districts. The basis for the higher level of unified district spending has not yet been determined. Similarly, unified districts averaged slightly higher tax rates (4.9821) than areas with separate elementary and high school districts for which average rates were 2.9321 and 2.0003, respectively, for a total of 4.9324. The revenue limit for each district, based on federal revenue limit criteria, is listed in column 5, Table 7.8. This limit will be a primary determinant of the impact on tax rates of geothermal development.

Trends in the cost of education per ADA are shown by school district in Table 7.9. Ten-year trends showing the slowest rate of cost increase have been in high school education for which the cost has doubled. Elementary school education in general tripled over this 10-yr period with Magnolia Union showing the largest increase at 364.7%. Over 250% of this increase however was recorded in FY 1974-1975; cost increases for

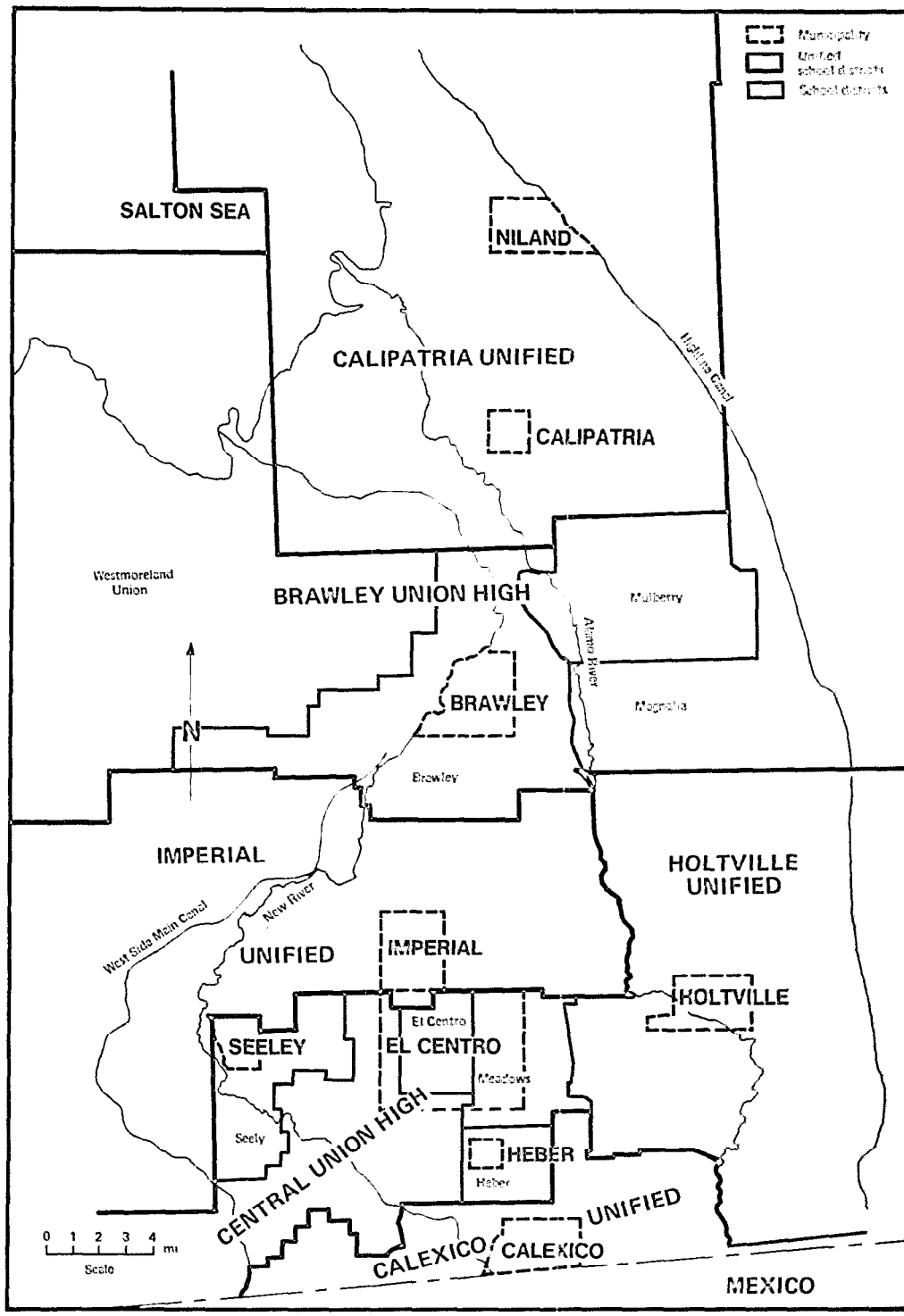

Fig. 7.2. Imperial County school districts.[7]

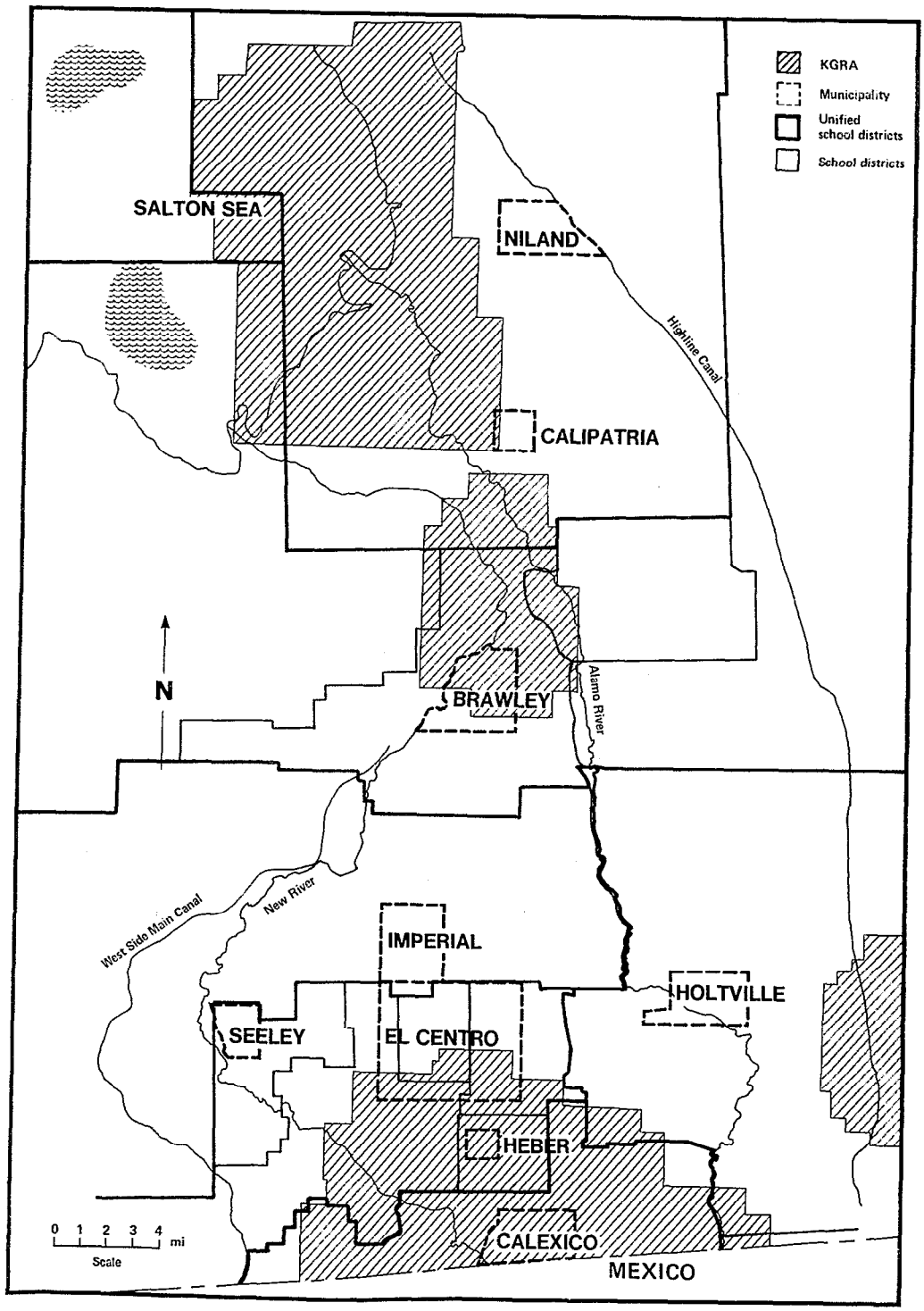

Fig. 7.3. Imperial County school districts mapped against KGRAs.[7]

Table 7.8. Imperial County school district fiscal summary for FY 1974-75.[7]

School district	Total district school tax rate	District assessed value (x$1000)	Value secured for tax rate (x$1000)	Annual ADA	Total revenue limit (using actual data)	Total funds available
Brawley (E)[a]	2.3102	34,774	30,991	3,553	2,892,010	4,161,287
El Centro (E)	2.7370	45,728	41,373	4,270	3,576,967	4,755,848
Heber (E)	3.6987	3,848	3,103	708	596,507	957,235
Magnolia (E)	1.9656	5,734	5,613	67	56,880	211,640
McCabe (E)	2.8644	11,824	10,173	285	204,001	381,430
Meadows (E)	3.8156	11,137	10,591	269	311,644	479,242
Mulberry (E)	2.6113	6,967	6,559	73	60,701	177,942
Seeley (E)	3.9722	4,401	3,635	496	421,549	896,826
Westmorland (E)	2.4140	11,389	10,455	443	332,540	484,975
Brawley (H)	2.0057	58,864	53,616	1,583	1,690,729	2,277,079
Central (H)	1.9948	76,938	68,804	2,376	2,336,917	2,982,178
Calexico (U)	4.8006	28,691	24,837	4,703	4,258,817	6,027,130
Calipatria (U)	4.9197	20,159	19,482	1,217	1,182,640	1,965,098
Holtville (U)	5.2405	34,019	31,562	1,956	1,871,307	2,997,740
Imperial (U)	4.0040	34,410	30,568	1,569	1,484,218	2,474,635
San Pasqual (U)	5.9456	7,227	6,691	638	711,520	1,465,526
ICC (C)	0.8810	260,299	235,513	2,808	3,325,425	8,011,109

[a]E = elementary school district; H = high school district; U = unified school district; C = comm

Table 7.9. Current cost[a] of education per A.D.A. in Imperial County (1964-1974).[7]

School districts:	1964-65	1965-66	1966-67	1967-68	1968-69	1969-7(
Elementary:						
Brawley	358.23	384.28	380.67	409.42	477.93	538.47
El Centro	375.96	456.84	473.75	498.10	548.63	577.35
Heber	363.59	337.03	391.63	429.89	508.86	560.19
Magnolia Union	444.92	534.08	549.96	530.18	555.66	608.77
McCabe Union	414.26	468.50	448.69	488.62	531.54	567.00
Meadows Union	395.37	414.34	457.09	502.21	618.80	733.40
Mulberry	535.58	654.66	628.52	572.62	810.16	914.24
Seeley Union	278.45	350.31	432.56	488.21	495.71	581.11
Westmorland Union	316.85	422.65	435.82	460.14	536.29	569.37
Elementary averages	368.08	458.87	462.52	492.14	522.06	627.77
High school:						
Brawley Union	660.63	696.18	801.49	798.05	835.73	928.75
Central Union	586.57	640.12	695.72	707.97	747.00	786.57
High school averages	599.12	672.24	748.60	753.01	784.26	857.66
Unified:						
Calexico	461.78	522.92	470.28	529.20	628.99	655.92
Calipatria	541.24	518.35	591.36	547.36	641.04	698.80
Holtville	735.36	829.76	608.49	644.13	700.96	742.48
Imperial	422.26	461.45	525.35	550.32	611.11	713.27
San Pasqual Valley	441.65	581.49	626.04	711.14	670.36	696.85
Unified averages	463.88	520.43	564.30	596.43	644.96	701.46
Imperial Community colleges	662.21	659.22	686.99	790.51	820.68	904.01

[a]Excludes cafeterias, community services and capital outlays.

Table 7.9. (Concluded)

School districts:	1970-71	1971-72	1972-73	1973-74	1974-75	1 c
Elementary:						
Brawley	577.23	625.92	538.88	795.55	953.91	+
El Centro	636.37	668.10	730.84	843.32	1,028.68	+
Heber	575.29	642.05	619.48	911.99	1,076.23	+
Magnolia Union	869.78	720.47	739.48	882.69	2,067.46	+
McCabe Union	662.19	718.61	756.30	937.13	1,089.37	+
Meadows Union	907.89	912.24	993.26	1,093.65	1,211.22	+
Mulberry	826.53	1,032.24	1,343.14	1,098.80	1,578.57	+
Seeley Union	611.64	645.17	711.69	838.57	933.16	+
Westmorland Union	584.32	709.50	654.79	859.16	969.68	+
Elementary averages	620.59	662.32	700.32	843.13	1,015.91	+
High school:						
Brawley Union	923.94	930.24	1,055.68	1,139.58	1,326.59	+
Central Union	795.28	887.39	975.79	1,062.27	1,185.67	+
High school averages	848.02	912.67	1,008.40	1,093.95	1,241.86	+
Unified:						
Calexico	691.59	742.82	762.50	870.32	1,121.40	+
Calipatria	701.97	806.82	855.64	1,023.16	1,219.33	+
Holtville	770.13	806.97	905.19	1,030.72	1,176.86	+
Imperial	698.52	786.60	875.45	1,050.21	1,425.03	+
San Pasqual Valley	803.80	968.14	1,071.34	1,359.83	1,770.08	+
Unified averages	717.02	786.36	840.45	978.52	1,234.01	+
Imperial Community colleges	979.49	1,093.65	1,199.69	1,163.66	1,926.85	+

Magnolia Union before that year were slightly below the average elementary school increase. Unified school districts showed the least consistency in recorded cost increases, varying from a low of +60% (Holtville) to a high of +300% (San Pasqual Valley). The average for unified school districts (+166.0%) was slightly below the elementary school average (+176.0%).

Table 7.10 shows assessed value per total ADA for each school district and the percentage change of this value over the past 5-yr period. Two significant facts are presented on this table. First, there is wide variation in the assessed value per ADA among school districts; this variation appears to be increasing rather than decreasing. Second, the assessed value of four districts has actually declined over the past five years, and in only one of these four cases, Heber Elementary, has there been a recent upward trend toward value recovery. The positive impact of geothermal development can potentially be felt most strongly in districts with decreasing assessed value or in districts with low assessed value per ADA.

As seen in Figs. 7.2 and 7.3, not all school districts stand an equal chance for receiving tax benefit from geothermal development. Imperial Unified, San Pasqual Valley Unified, and Seeley Elementary School Districts do not overlap with any of the KGRAs. Magnolia Elementary, Mulberry Elementary, Westmorland Elementary, and El Centro Elementary School Districts have extremely limited overlap with KGRAs. Almost all of the overlap of the Mulberry District with the Brawley KGRA lies within a zone designated by the county for preservation. El Centro Elementary School District's overlap with the Heber KGRA is all within municipal boundaries, thus can not be considered for geothermal plant siting. The remaining nine school districts will be the principal beneficiaries of geothermal development. Calipatria Unified School District covers essentially all of the Salton Sea KGRA and the northern third of the Brawley KGRA. Brawley Union High School and Brawley Elementary School jointly cover the southern two-thirds of the Brawley KGRA. Five districts (Calexico Unified, Central Union High, McCabe Elementary, Heber Elementary, and Meadows Elementary) split coverage of the Heber KGRA with Calexico Unified District having the largest land overlap. Holtville Unified District covers all of the East Mesa KGRA, has several small overlaps with the Heber KGRA, and also completely contains two smaller, lower potential KGRAs, the Dunes and Glamis KGRAs (both located east of Imperial Valley).

Table 7.10. Imperial County school district assessed value[a] (1970-1975).[7]

School districts:	1970-71	1971-72	1972-73	1973-74	1974-75	5 yr % change
Elementary:						
Brawley	7,178	7,295	7,829	8,143	9,320	+29.8
El Centro	7,241	7,472	8,495	8,645	9,002	+24.3
Heber	7,057	5,938	4,834	4,532	5,256	-25.5
Magnolia Union	47,848	50,910	47,948	52,538	75,028	+56.8
McCabe Union	31,416	35,091	32,603	32,829	37,882	+20.6
Meadows Union	26,795	28,113	37,541	36,591	34,042	+27.0
Mulberry	63,656	70,185	74,699	54,588	79,462	+24.8
Seeley Union	5,764	6,268	7,483	7,700	8,215	+42.5
Westmorland Union	20,908	21,825	20,704	21,320	21,070	+ 0.8
High school:						
Brawley Union	29,597	29,126	30,886	30,925	34,271	+15.8
Central Union	23,352	23,776	26,927	27,138	28,143	+20.5
Unified:						
Calexico----------Elementary	6,679	7,203	7,177	6,777	8,906	+33.3
High school	14,486	15,758	16,312	15,932	20,484	+41.4
Calipatria---------Elementary	19,803	20,247	21,800	22,326	23,754	+20.0
High school	56,976	55,696	54,855	51,208	49,817	+12.6
Holtville----------Elementary	20,401	20,369	21,008	21,447	22,194	+ 8.8
High school	42,866	40,494	44,407	43,433	47,806	+11.5
Imperial----------Elementary	21,109	20,959	22,529	23,801	26,928	+27.6
High school	57,495	58,033	60,367	58,634	61,623	+ 7.2
San Pasqual Valley-Elementary	14,373	14,333	15,733	16,409	17,236	+19.9
High school	53,162	49,732	54,216	51,108	50,530	- 5.0
Imperial Community College	100,821	102,106	111,631	91,811	83,259	-17.4

[a]Numbers listed are assessed valuation per total ADA.

7.4 IMPERIAL COUNTY LAND USE PLANNING

Existing county land use plans and the locations of state and federal wildlife areas could significantly restrict the spatial development of geothermal energy. The principal effect of these restrictions will be to concentrate future large-scale geothermal activity. It has not been determined whether these spatial restrictions will significantly impede ultimate resource development. There are three sources of land-use restrictions that are addressed by our study program: county zoning ordinances; the county Ultimate Land Use Plan; and proposed county regulation governing geothermal operations, plant permitting, and

plant siting within Imperial County (similar to that for well drilling operations[8]). Once the Geothermal Element for the County General Plan has been adopted, it will replace the last of these three regulations and will clarify the relationship between geothermal energy and the first two regulatory elements.

Zoning Ordinances

Imperial County zoning codes now provide an overlay zone designation G to indicate that geothermal activity is allowable within that general zone. To date this designation has been applied only to major test and demonstration plant sites in the Salton Sea KGRA. Adoption of a geothermal element to the county general plan will clarify the application of this overlay zone designation. In the absence of this elemen' a preliminary review of the county zone codes indicates that geothermal activity would now be excluded from the following zones: all residential zones R-1, R-1-T, R-2, R-3, R-4, and R-4-T; agricultural zones R-A and A-1; all commercial zones C-0, C-1, and C-2; manufacturing zone M-1; recreation zones F; and the open space zones S. This leaves the following zones available for location of geothermal development: agricultural zones A-2, A-3, and A-2-R and manufacturing zone M-2. Those county zones that would restrict geothermal development are mapped against county boundaries in Fig. 7.4. Existing zoning patterns will create only minor restrictions on overall development. The restricted areas comprise primarily city boundaries and recreational zones with the largest recreational zone being along the Salton Sea shore line.

Ultimate Land Use Plan

Assuming that Imperial County will retain its existing Ultimate Land Use Plan and require compatability of geothermal development with this plan, we mapped ultimate land use against KGRA boundaries in Fig. 7.5. Land use zones that would exclude geothermal development are urban, rural residential, recreation, preservation, and special public areas. Since no industrial or desert residential areas overlay major KGRAs, this plan places all geothermal development on general agricultural lands.

Geothermal Element

County regulations for permitting and siting of geothermal powerplants are still being formulated. Restrictions for such facilities generally require minimum distances between the plant and community boundaries, schools, hospitals, feed lots, etc. Figure 6.4 shows the relationship

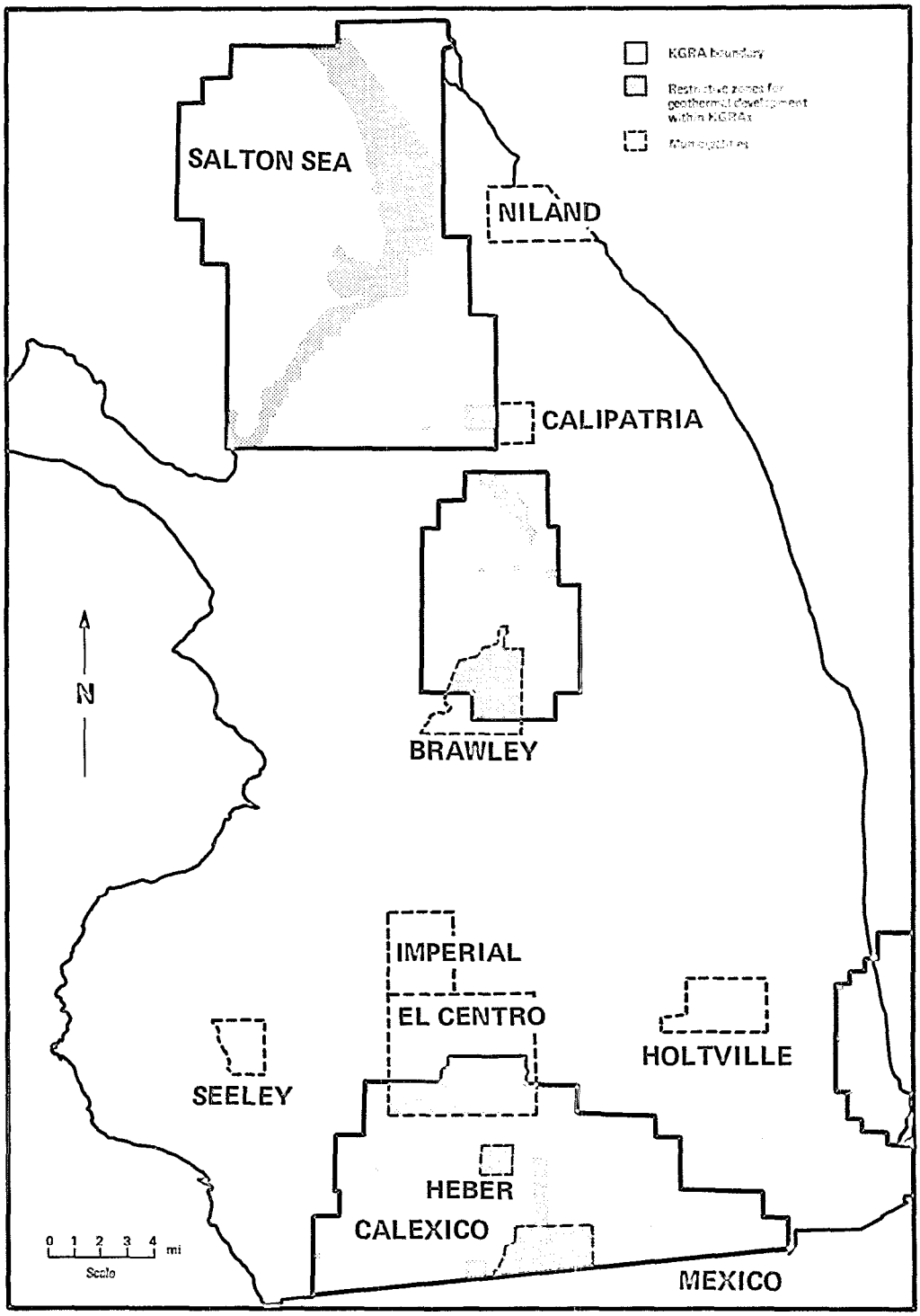

Fig. 7.4. Imperial County restrictive land use zones mapped against KGRA boundaries.[9]

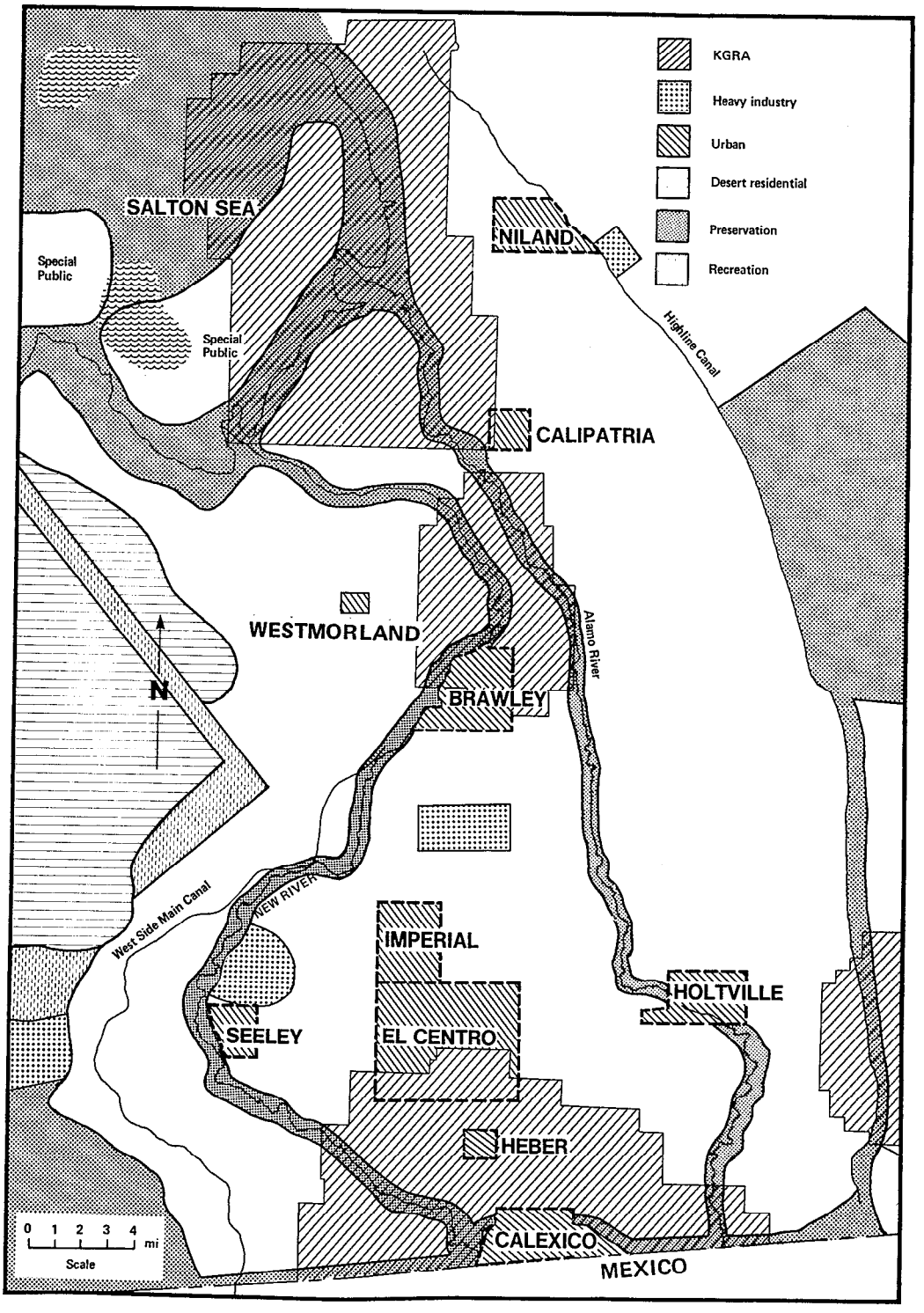

Fig. 7.5. Imperial County ultimate land use plan mapped against KGRAs.[10]

between KGRAs and all feed lots within the county. Application of minimum distance requirements to the feed lot distributions would create several exclusion zones of significant size for geothermal development.

The net effect of these land use restrictions would force geothermal development to compete almost exclusively with agriculture for land use. The significance and magnitude of this competition will be a function of the number of plants to be located in each KGRA, of spacings of wells and reinjection wells, and requirements for and patterns of brine piping. These factors are, in turn, a function of the extent to which geothermal development takes place.

7.5 INTRACOUNTY FISCAL DESCRIPTION

Municipal Services

Individual city budgets were not analyzed for this report. However, most Imperial County cities are relatively small (population of 10,000 or less); for units of that size, per capita fiscal budget analysis is less reliable for predicting future fiscal expenditures than it is for large units. For small fiscal units, a marginal analysis approach will be used. Present expansion capacity of the various municipal services can be estimated and incremental costs of expanding those services can be calculated. These figures may then be used to predict municipal fiscal costs for each service for some future period.

As a first step toward such an analysis, a basic description of the four major municipalities (Brawley, Calexico, El Centro, and Holtville) in Imperial County was obtained from unpublished data.[11]

Brawley

Brawley urban water supplies are obtained from IID by the Brawley County Water District. Current (late 1975) average daily consumption for Brawley is approximately 6.5 million gal. The municipal district has a 10-da-storage reserve, pretreatment settling basins and facilities for chemical mixing, filtration, and chlorination. The 11-pump distribution system has a capacity of 276,000 gal/min and has a minimum pipe size of 4 in. Electricity is supplied throughout Brawley exclusively by IID and natural gas by the Southern California Gas Company. There is one fire station in Brawley staffed by 19 men and several additional reserve personnel. The city has received a class four insurance rating but a recent report in the Imperial Valley

Press (May 12, 1976) states that this rating will be changed to a class five unless substantial updating of the fire department is undertaken. There are currently 20 sworn Brawley policemen and 7 nonsworn staff personnel. The city currently maintains 102 acres of park area distributed among 9 park sites. The largest of these, New River Park, is 66.6 acres with all remaining parks below 10 acres in size. The Pioneers Memorial Hospital, part of a special district local government, is partially tax supported and provides a 78-bed capacity for the Brawley area. In addition the Clinica de Salubridad de Campesinos Clinic in Brawley, for migrant workers, serves between 75 to 100 per day. Finally, the city provides solid waste disposal service throughout Brawley. Refuse is transferred to a county sanitary landfill.

Calexico

Water and sewer service in Calexico are supplied through the municipality. System capacity is 15.4 million gpd. City calculations for 1975 indicate an average consumption of 2.75 million gpd. Eletricity and gas are supplied in Calexico, as in Brawley, by IID and Southern California Gas Company, respectively. The city fire department employs 2 full-time and 18 part-time firemen with 11 reserve volunteers, all based from one central station. The department has 5 trucks, the largest of which has a 500 gpm capacity. The police department employs 24 sworn officers and has 7 patrol cars all based in 1 central facility. There are seven parks within city limits all of which are city owned and maintained. Total park acreage has not yet been obtained. There is a 34-bed-capacity hospital in Calexico with a professional staff of 12 doctors.

El Centro

El Centro residents are provided with water and sewer services by the city. The city also operates solid waste disposal service. Gas and electricity service is provided privately as in Brawley and Calexico. The El Centro fire department has 9 trucks, 30 full-time firemen and maintains 2 stations. The department is also under contract with the county to protect county areas surrounding El Centro. There are 35 sworn officers in the El Centro police department and 15 patrol cars. Only one station is maintained and all activities are centrally located in that facility. The city of El Centro maintains 54 acres of park within city boundaries. Twenty acres are located in Bucklin Park with the remaining 34 acres scattered throughout the city as small neighborhood

parks. The El Centro Community Hospital with a capacity of 92 beds, and the Valley Convalescent Hospital with a capacity of 120 beds serve El Centro for health services. El Centro also has a central city public library.

Holtville

Water and sewer service within city limits are provided by the city; however, system capacity and treatment data have not yet been obtained. Solid waste disposal service is operated by the city. The city fire department has three city-owned trucks and one county-owned truck available for emergency use, all located in one station house. There are 10 sworn police officers and 1 nonsworn full-time employee. Holtville has four parks within city limits, two of which (including Angels Park, the spring training camp for the California Angels) are dedicated to baseball fields. These parks comprise 12.6 acres or 2.1% of Holtville city area. There is a small county operated public library in Holtville.

The relationship between city boundaries and KGRAs is given in Fig. 7.6 with overlapping areas darkened. Since current county regulations prohibit geothermal development within city boundaries, these overlap areas represent additional geothermal exclusion zones within KGRAs. However, the proximity of each city to the various KGRAs is still very important since nearby communities will be strongly affected by population influxes and general economic activity associated with geothermal development on each KGRA.

Federal Governmental Influence Within the County

Table 7.6 lists direct county fiscal revenues from federal agencies. However, the total dollar expenditure of the federal government within the county through federal projects, payrolls, other than direct county subsidies, etc., is much larger than the $9+ million shown in Table 7.6. Table 7.11 shows Imperial County calculations of the total direct economic influence of the various federal agencies. These total expenditure figures make the federal government the second largest industry in the county, surpassed only by agriculture.

Table 7.11. Federal government expenditures in Imperial County.[10]

	Federal agency	Expenditures (thousands of dollars) 1970 F.Y.	1972 F.Y.
1.	Department of Health, Education and Welfare	22,450	30,345
2.	Department of Agriculture	20,738	16,031
3.	Department of Defense	7,969	10,722
4.	Department of Transportation	11,544	9,197
5.	General Services Administration	362	5,370
6.	Department of Justice	2,972	3,891
7.	Treasury Department	3,649	3,446
8.	Department of Interior	4,761	2,013
9.	Civil Service Commission	1,201	1,666
10.	Department of Labor	404	1,359
	Other	5,028	3,706
	Total	81,078	87,746

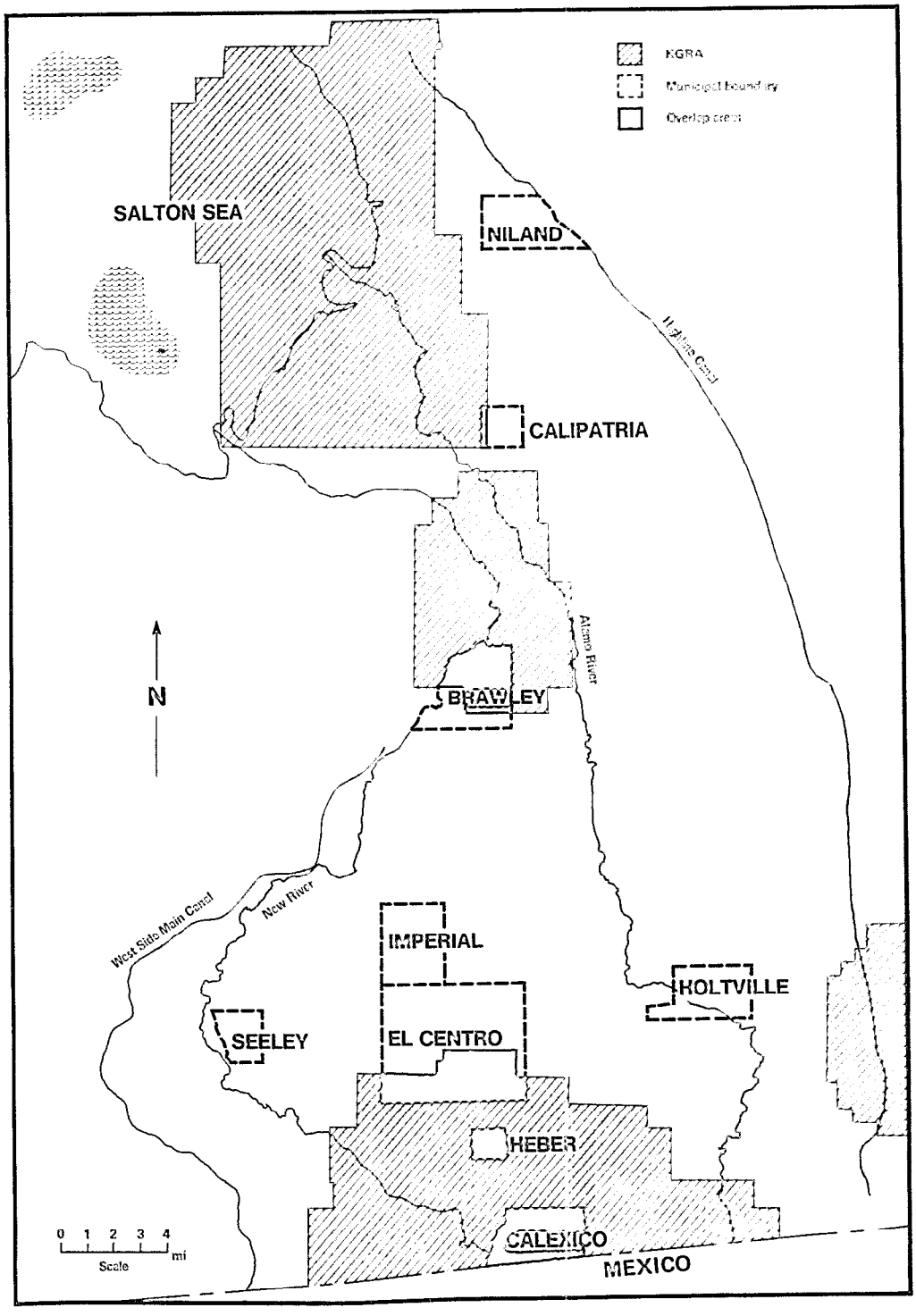

Fig. 7.6. Imperial Valley city boundary overlap with KGRAs.

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Section 8
Social Characterization of Imperial County

Kendall Haven

8.1 IMPERIAL COUNTY SOCIOLOGICAL DESCRIPTION

The primary informational source for this section is the 1970 county level census data.[1] Portions of this data are updated annually by various state and local agencies with most of this work being done by the State Department of Finance. However, these are estimates based on 1970 census data based on historical trends. These estimates are made for only a small percentage of the total number of parameters calculated by the census survey. As a result, a more reliable, complete social composite can be created from 6-year-old census data than from the available updated estimates. Our study is based on 1970 census survey data augmented where appropriate with updated information. Five groups of the census data were selected for use in this characterization: distribution by age, distribution by racial groups, educational attainment, and income level, and two poverty indicators. A summary of this data for Imperial County is presented in Tables 8.1 through 8.4.

Data presented in Tables 8.1 through 8.4 were also collected to compare all California counties. Location quotients were calculated for each parameter to determine if Imperial County social distribution was similar to that of other counties. (See Tables 8.5 and 8.8).

The age distribution shown in Table 8.1 is somewhat unusual. The population of each group may be divided by the age span of that group to obtain an estimate of the number of people of a given age. These results are plotted in Fig. 8.1 Comparing these figures with data presented in Table 8.5, we find that Imperial County has a higher concentration of both children and young teenagers than any other county in the state, yet it ranks 17th from the bottom for concentration of 18 to 24 year old group. This indicates two things: First, a substantial post high school migration out of the county, and second, a high average number of dependent children per family. The high number of dependent children per family may be translated into a high fertility rate for the county. This phenomenon has also been noted and reported by Pick.[2] In addition, Imperial County is relatively low in Black, Japanese, and Chinese populations, but, as

Table 8.1. Imperial County population distribution by age group (1970).[1]

Age group	Number of county persons in group	% Total county population	Cumulative %
0 through 13	23,918	32.1	32.1
14 through 17	7251	9.8	41.9
18 through 24	7072	9.5	51.4
25 through 34	8363	11.2	62.6
35 through 44	8368	11.2	73.8
45 through 54	7682	10.3	84.1
55 through 64	6245	8.4	92.5
over 64	5575	7.5	100.0
Total	74,492	100%	

Table 8.2. Imperial County population distribution by racial group (1970).[1]

Racial group	Number of persons in group	% of Total county population
White	68,806	92.4
Black	2,586	3.5
American Indian	889	1.2
Japanese	206	0.3
Chinese	412	0.6
Filipino	731	1.0
Other	862	1.2
Total	74,492	100.2
Spanish American (4th count data)	34,260	46.0

Table 8.3. Imperial County educational attainment for persons 25 years and older (1970).[1]

Highest grade completed	Number of county persons	% Total (25 yrs and older)
Below grade 8	10,305	28.4
Grade 8	4,152	11.4
Grades 9-11	6,179	17.1
Grade 12	8,924	24.6
Grades 13-15	4,029	11.1
Grade 16 and over	2,662	7.3
Total	36,251	99.9

Table 8.4. Imperial County income and poverty indicators (1970).[1]

Annual income	Number of county families	% Total number of families	Number of county unrelated individuals	% Total number of individuals
Less than $4,000	3,086	17.9	3,256	68.9
$4,000 — $6,000	2,588	15.0	548	11.6
$6,000 — $8,000	2,630	15.2	377	8.0
$8,000 — $10,000	2,316	13.4	243	5.1
$10,000 — $15,000	3,952	22.9	203	4.3
$15,000 — $25,000	2,102	12.2	101[a]	2.1
Over $25,000	587	3.4		
Total	17,261	100.0	4,728	100.0
Number below poverty level	2,781	16.1	1,692	35.8

[a]Includes all unrelated individuals with income over $15,000 annually.

Table 8.5. Age distribution location quotients for California counties.

COUNTY \ AGE GROUP	0-13	14-17	18-24	25-34	35-44	45-54	55-64	65-	WHITE	BLACK	AM. INDIAN
ALAMEDA	0.942	0.942	1.128	1.045	0.953	1.002	1.005	1.026	0.896	2.142	1.162
ALPINE	0.898	0.652	0.816	1.284	1.044	1.508	0.674	0.183	0.873	0.029	43.935
AMADOR	0.809	1.084	0.965	0.787	0.773	1.13F	1.482	1.530	1.072	0.392	2.967
BUTTE	0.865	0.980	1.168	0.803	0.793	0.944	1.244	1.559	1.082	0.223	1.913
CALAVERAS	0.814	1.094	0.572	0.811	0.865	1.000	1.706	1.809	1.071	0.146	2.759
COLUSA	0.701	1.143	0.731	0.833	0.920	0.974	1.308	1.293	1.064	0.099	2.328
CONTRA COSTA	1.081	1.137	0.826	0.962	1.086	1.122	0.961	0.769	1.016	1.068	0.671
DEL NORTE	1.083	1.097	0.762	0.810	1.017	1.045	1.162	1.047	1.057	0.033	10.931
EL DORADO	0.954	1.049	0.770	0.884	1.085	1.125	1.232	1.074	1.107	0.020	1.150
FRESNO	1.070	1.130	1.002	0.893	0.932	0.959	0.978	1.006	1.013	0.703	1.138
GLENN	0.982	1.182	0.674	0.751	1.000	1.019	1.303	1.391	1.099	0.050	2.352
HUMBOLT	0.991	1.053	1.135	0.938	0.925	0.959	1.085	0.957	1.074	0.066	6.718
IMPERIAL	1.246	1.280	0.781	0.841	0.946	0.885	0.977	0.826	1.038	0.495	2.616
INYO	0.940	1.022	0.650	0.825	1.029	1.080	1.484	1.279	1.030	0.022	16.472
KERN	1.115	1.148	0.874	0.928	0.970	0.961	1.031	0.881	1.025	0.807	1.358
KINGS	1.168	1.088	1.161	0.989	0.918	0.786	0.838	0.779	1.002	0.724	1.185
LAKE	0.727	0.830	0.483	0.577	0.770	1.048	1.989	2.538	1.089	0.031	3.622
LASSEN	0.919	1.074	0.917	0.245	0.785	0.845	0.669	0.956	0.948	0.283	4.555
LOS ANGELES	0.970	0.955	0.943	1.020	1.017	1.048	1.059	1.027	0.959	1.545	0.764
MADERA	1.064	1.197	0.763	0.770	0.933	0.948	1.272	1.206	1.020	0.677	3.949
MARIN	0.960	0.995	0.799	1.112	1.206	1.090	0.964	0.869	1.077	0.349	0.406
MARIPOSA	0.825	0.890	0.784	0.716	0.929	1.065	1.531	1.805	1.075	0.071	7.326
MENDOCINO	0.975	1.085	0.725	0.883	0.958	1.051	1.313	1.227	1.076	0.081	6.148
MERCED	1.168	1.154	1.008	0.918	0.949	0.889	0.892	0.812	1.036	0.749	0.746
MODOC	0.928	1.263	0.608	0.823	0.924	1.172	1.350	1.316	1.083	0.038	5.078
MONO	0.921	1.153	0.795	1.074	1.175	1.024	1.292	0.723	1.066	0.	10.372
MONTEREY	0.981	1.010	1.575	0.947	0.874	0.868	0.846	0.830	0.990	0.692	0.998
NAPA	0.903	1.016	0.870	0.848	0.914	1.081	1.196	1.481	1.092	0.093	0.596
NEVADA	0.852	0.983	0.642	0.672	0.886	1.042	1.658	1.868	1.111	0.020	0.932
ORANGE	1.115	1.079	0.931	1.061	1.114	0.965	0.722	0.767	1.093	0.102	0.605
PLACER	0.972	1.148	0.792	0.864	1.032	1.053	1.202	1.132	1.091	0.064	1.171
PLUMAS	0.927	1.190	0.555	0.805	1.022	1.175	1.541	1.165	1.068	0.243	5.711
RIVERSIDE	1.022	0.992	0.872	0.883	0.905	0.891	1.106	1.459	1.046	0.659	1.399
SACRAMENTO	1.061	1.100	0.965	0.962	1.051	1.042	0.929	0.787	1.007	0.822	0.927
SAN BENITO	1.121	1.177	0.812	0.865	0.893	0.918	1.066	1.139	1.082	0.049	0.650
SAN BERNARDINO	1.084	1.066	0.967	0.940	0.944	0.915	0.958	1.058	1.058	0.612	1.112
SAN DIEGO	0.954	0.975	1.419	0.947	0.929	0.910	0.900	0.968	1.036	0.651	0.949
SAN FRANCISCO	0.670	0.687	1.103	1.117	0.952	1.044	1.370	1.545	0.802	1.913	0.888
SAN JOAQUIN	1.005	1.080	0.936	0.865	0.941	1.045	1.099	1.125	0.990	0.775	0.920
SAN LUIS OBISBO	0.821	0.926	1.408	0.903	0.807	0.932	1.158	1.355	1.060	0.308	1.072
SAN MATEO	0.954	1.003	0.894	1.043	1.062	1.153	1.086	0.845	1.025	0.668	0.528
SANTA BARBARA	0.989	0.976	1.272	0.985	0.955	0.888	0.891	1.010	1.061	0.346	0.836
SANTA CLARA	1.120	1.028	1.004	1.155	1.046	0.934	0.742	0.668	1.059	0.242	0.833
SANTA CRUZ	0.857	0.908	1.017	0.804	0.865	0.913	1.209	1.837	1.076	0.095	0.638
SHASTA	1.053	1.131	0.781	0.941	0.995	0.991	1.159	0.989	1.089	0.117	3.730
SIERRA	0.867	0.921	0.469	0.718	0.972	1.143	2.091	1.389	1.105	0.031	3.695
SISKIYOU	0.948	1.110	0.736	0.799	1.003	1.103	1.325	1.259	1.057	0.300	6.377
SOLANO	1.080	0.997	1.237	1.025	0.960	0.935	0.803	0.742	0.958	1.397	1.398
SONOMA	0.988	1.032	0.869	0.879	0.896	0.951	1.145	1.420	1.085	0.147	1.737
STANISLAUS	1.048	1.125	0.860	0.886	0.962	0.961	1.078	1.138	1.093	0.142	0.773
SUTTER	1.083	1.127	0.865	0.974	0.985	0.948	1.043	0.920	1.065	0.067	1.093
TEHAMA	1.040	1.054	0.741	0.913	0.936	0.988	1.128	1.291	1.099	0.048	2.273
TRINITY	1.014	1.149	0.541	0.903	0.914	1.196	1.355	1.115	1.075	0.007	8.262
TULARE	1.105	1.212	0.828	0.857	0.902	0.929	1.094	1.093	1.059	0.242	1.592
TUOLUMNE	0.857	1.046	0.725	0.950	0.990	1.080	1.418	1.374	1.077	0.165	5.419
VENTURA	1.208	1.094	0.856	1.040	1.095	0.881	0.752	0.725	1.078	0.241	0.670
YOLO	0.989	0.966	1.529	1.024	0.877	0.869	0.868	0.770	1.062	0.178	1.137
YUBA	1.204	0.999	1.108	1.046	1.010	0.736	0.794	0.726	1.027	0.686	1.029

Table 8.6. Racial group distribution location quotients for California counties (1970).

COUNTY \ RACIAL GROUP	JAPANESE	CHINESE	FILIPINO	OTHER	SPAN.AMER.	0-8	8	9-11	12	13-15	16-
ALAMEDA	0.892	2.194	1.419	0.983	0.609	0.903	0.961	1.012	1.029	0.913	1.094
ALPINE	0.	0.	5.641	0.	0.	0.895	1.384	0.927	1.133	1.817	0.226
AMADOR	0.040	0.189	0.049	0.255	0.486	0.777	1.833	1.170	1.095	1.148	0.685
BUTTE	0.157	0.282	0.096	0.852	0.326	0.953	1.524	1.146	0.973	0.933	0.843
CALAVERAS	0.021	0.035	3.226	0.090	0.354	1.184	1.778	1.571	1.117	0.927	0.654
COLUSA	0.376	0.415	0.046	3.091	1.104	1.065	1.443	1.217	0.933	0.909	0.765
CONTRA COSTA	0.670	0.652	0.715	0.538	0.592	0.731	0.843	0.931	1.023	1.015	1.269
DEL NORTE	0.122	0.016	0.030	0.626	0.297	0.942	1.729	1.390	0.995	0.914	0.546
EL DORADO	0.120	0.142	0.449	0.234	0.284	0.700	1.290	1.121	1.194	1.070	0.828
FRESNO	1.406	0.662	0.356	2.286	1.623	1.639	1.163	0.943	0.810	0.839	0.717
GLENN	0.048	0.241	0.172	0.453	0.633	1.153	1.720	1.204	1.105	0.794	0.548
HUMBOLT	0.107	0.101	0.130	0.630	0.259	0.803	1.513	1.176	0.944	0.804	0.716
IMPERIAL	0.259	0.649	1.410	1.292	2.959	2.305	1.167	0.835	0.670	0.605	0.438
INYO	0.072	0.053	0.074	0.559	0.470	0.827	1.180	1.296	1.301	0.921	0.764
KERN	0.178	0.313	0.911	1.554	1.081	1.452	1.261	1.080	0.840	0.790	0.631
KINGS	0.441	0.430	1.262	1.456	1.502	1.634	1.205	0.857	0.792	0.870	0.555
LAKE	0.062	0.042	0.206	1.091	0.286	1.196	2.437	1.611	1.240	0.862	0.676
LASSEN	0.067	0.014	0.111	0.519	0.409	0.821	1.329	1.403	1.140	0.855	0.593
LOS ANGELES	1.334	0.660	0.633	0.950	1.179	1.066	0.930	1.078	1.029	1.042	0.978
MADERA	0.370	0.336	0.333	1.918	1.542	2.194	1.642	1.113	0.757	0.586	0.517
MARIN	0.479	0.497	0.227	0.444	0.375	0.415	0.690	0.655	0.993	1.411	2.106
MARIPOSA	0.023	0.078	0.024	0.316	0.165	0.981	1.625	1.473	1.120	0.935	0.962
MENDOCINO	0.146	0.227	0.186	0.374	0.323	1.024	1.480	1.223	1.114	0.947	0.735
MERCED	0.570	0.250	0.475	1.191	1.473	1.599	1.328	0.855	0.826	0.805	0.553
MODOC	0.088	0.	0.019	1.017	0.480	0.730	1.600	1.217	1.296	0.912	0.561
MONO	0.116	0.	0.	0.334	0.077	0.278	1.407	1.003	1.206	1.361	0.832
MONTEREY	1.214	0.631	3.949	2.320	1.356	1.063	0.894	0.765	0.886	0.891	0.981
NAPA	0.203	0.479	0.345	1.092	0.434	0.804	1.423	1.022	1.121	1.157	0.906
NEVADA	0.060	0.295	0.033	0.199	0.204	0.781	1.711	1.211	1.214	1.173	0.835
ORANGE	0.701	0.234	0.318	0.623	0.735	0.541	0.740	0.884	1.012	1.144	1.119
PLACER	1.202	0.184	0.063	0.488	0.509	0.914	1.306	0.950	1.163	1.003	0.770
PLUMAS	0.040	0.100	0.012	0.525	0.282	0.776	1.448	1.273	1.243	0.967	0.749
RIVERSIDE	0.300	0.132	0.403	1.004	1.116	1.174	1.223	1.054	1.004	0.953	0.805
SACRAMENTO	1.452	1.790	0.933	0.671	0.592	0.815	0.929	0.990	1.054	0.956	0.939
SAN BENITO	0.570	0.219	1.167	1.611	2.839	2.157	1.491	0.958	0.728	0.709	0.462
SAN BERNARDINO	0.224	0.137	0.242	1.035	1.032	1.005	1.145	1.161	0.961	0.940	0.857
SAN DIEGO	0.518	0.282	1.558	1.040	0.825	0.713	0.960	0.953	0.990	0.936	0.967
SAN FRANCISCO	1.530	9.518	4.958	1.625	0.916	1.556	1.172	0.993	1.053	1.125	1.461
SAN JOAQUIN	1.241	1.486	3.512	1.141	1.150	1.691	1.443	1.096	0.837	0.756	0.593
SAN LUIS OBISPO	0.550	0.403	1.127	1.292	0.714	0.973	1.342	1.018	0.906	1.040	0.831
SAN MATEO	0.943	1.134	1.456	0.836	0.729	0.836	0.797	0.890	1.130	1.200	1.331
SANTA BARBARA	0.727	0.355	0.802	1.276	1.116	0.719	0.890	0.754	0.909	1.106	1.261
SANTA CLARA	1.432	0.831	0.903	0.786	1.127	0.925	0.775	0.786	0.904	1.022	1.359
SANTA CRUZ	1.061	0.575	1.157	0.926	0.751	1.035	1.274	0.970	1.045	1.181	1.059
SHASTA	0.072	0.106	0.051	0.325	0.217	0.793	1.248	1.234	1.096	0.899	0.644
SIERRA	0.	0.051	0.052	2.075	0.245	1.183	1.728	1.218	1.303	0.942	0.831
SISKIYOU	0.073	0.073	0.022	0.514	0.300	1.058	1.685	1.131	1.183	0.923	0.599
SOLANO	0.913	0.591	2.511	1.386	0.697	0.756	0.932	0.990	1.008	0.790	0.526
SONOMA	0.210	0.236	0.270	0.649	0.477	0.903	1.210	0.990	1.106	0.955	0.850
STANISLAUS	0.159	0.251	0.193	0.563	0.813	1.445	1.610	1.087	0.887	0.774	0.605
SUTTER	1.443	0.533	0.514	1.997	0.999	1.137	1.281	1.011	0.921	0.915	0.776
TEHAMA	0.073	0.107	0.038	0.332	0.376	0.980	1.551	1.215	1.134	0.768	0.594
TRINITY	0.012	0.123	0.007	0.381	0.114	0.775	1.696	1.389	1.054	0.982	0.762
TULARE	0.459	0.275	1.273	1.904	1.091	2.044	1.597	0.982	0.731	0.701	0.513
TUOLUMNE	0.059	0.042	0.052	0.403	0.448	0.779	1.577	1.374	1.147	1.014	0.609
VENTURA	0.617	0.222	0.592	0.830	1.239	0.905	0.933	0.911	0.973	0.942	0.944
YOLO	1.029	1.078	0.631	1.305	1.075	0.971	1.076	0.904	0.801	0.746	1.223
YUBA	0.542	0.393	0.491	1.852	0.473	1.055	1.152	0.933	0.995	0.745	0.533

Table 8.7. Educational attainment location quotients for California counties (1970).

County	Highest grade attained <8	8	9-11	12	13-15	16 and over
Alameda	0.998	0.961	1.012	1.029	0.913	1.094
Alpine	0.895	1.384	0.927	1.133	1.317	0.226
Amador	0.777	1.833	1.170	1.095	1.148	0.685
Butte	0.958	1.524	1.146	0.973	0.933	0.843
Calaveras	1.184	1.778	1.571	1.117	0.927	0.654
Colusa	1.065	1.448	1.217	0.985	0.909	0.765
Contra Costa	0.731	0.846	0.931	1.023	1.015	1.269
Del Norte	0.942	1.729	1.390	0.995	0.614	0.546
El Dorado	0.700	1.290	1.121	1.194	1.070	0.828
Fresno	1.639	1.163	0.943	0.810	0.839	0.717
Glenn	1.153	1.720	1.204	1.105	0.794	0.548
Humboldt	0.803	1.518	1.176	0.944	0.804	0.716
Imperial	2.305	1.167	0.866	0.670	0.605	0.488
Inyo	0.827	1.180	1.296	1.301	0.921	0.764
Kern	1.452	1.261	1.080	0.848	0.790	0.631
Kings	1.684	1.205	0.867	0.792	0.570	0.555
Lake	1.196	2.437	1.611	1.240	0.862	0.676
Lassen	0.821	1.329	1.403	1.140	0.855	0.583
Los Angeles	1.066	0.980	1.078	1.029	1.042	0.978
Madera	2.194	1.642	1.113	0.757	0.586	0.517
Marin	0.415	0.698	0.655	0.998	1.411	2.106
Mariposa	0.981	1.625	1.473	1.120	0.935	0.862
Mendocino	1.024	1.480	1.223	1.114	0.847	0.735
Merced	1.599	1.328	0.855	0.826	0.665	0.553
Modoc	0.730	1.600	1.217	1.296	0.912	0.561
Mono	0.278	1.407	1.003	1.206	1.361	0.832
Monterey	1.063	0.894	0.765	0.826	0.891	0.981
Napa	0.804	1.423	1.022	1.121	1.157	0.906
Nevada	0.781	1.711	1.211	1.214	1.173	0.835
Orange	0.541	0.740	0.884	1.012	1.144	1.119
Placer	0.914	1.306	0.960	1.163	1.036	0.770
Plumas	0.776	1.448	1.273	1.243	0.987	0.749
Riverside	1.174	1.223	1.064	1.004	0.963	0.805
Sacramento	0.815	0.929	0.900	1.054	0.994	0.939
San Benito	2.157	1.494	0.958	0.728	0.709	0.462
San Bernardino	1.005	1.145	1.161	0.961	0.849	0.657
San Diego	0.713	0.860	0.963	0.990	0.936	0.967
San Francisco	1.556	1.172	0.998	1.053	1.125	1.461
San Joaquin	1.691	1.448	1.096	0.887	0.756	0.593
San Luis Obisbo	0.973	1.342	1.018	0.966	1.046	0.831
San Mateo	0.636	0.797	0.898	1.130	1.200	1.331
Santa Barbara	0.719	0.690	0.754	0.989	1.106	1.261
Santa Clara	0.925	0.775	0.788	0.904	1.022	1.359
Santa Cruz	1.035	1.274	0.976	1.045	1.181	1.059
Shasta	0.793	1.248	1.234	1.046	0.989	0.644
Sierra	1.188	1.728	1.218	1.308	0.942	0.831

Table 8.7. (Concluded)

Siskiyou	1.068	1.685	1.131	1.183	0.823	0.599
Solano	0.756	0.932	0.990	1.088	0.790	0.626
Sonoma	0.908	1.210	0.960	1.106	1.086	0.850
Stanislaus	1.446	1.610	1.087	0.887	0.774	0.605
Sutter	1.137	1.281	1.011	0.924	0.915	0.776
Tehama	0.960	1.551	1.216	1.144	0.758	0.564
Trinity	0.775	1.666	1.329	1.054	0.982	0.762
Tulare	2.044	1.567	0.982	0.731	0.701	0.513
Tuolumne	0.779	1.577	1.374	1.247	1.014	0.669
Ventura	0.905	0.838	0.911	0.973	0.942	0.844
Yolo	0.971	1.076	0.804	0.801	0.746	1.223
Yuba	1.055	1.152	0.938	0.925	0.745	0.533

would be expected, is very high in Spanish-Americans (see Table 8.6). The county ranks fairly low in adult educational attainment (see Table 8.7) with the highest concentration of adults with less than an eighth grade education, an average concentration of adults with an eighth grade education, and steadily decreasing rankings for higher educational levels. This educational profile can be related to the characteristics of employment and agricultural patterns in the county. For example, both Fresno and Kern counties (two other agriculturally based counties using large quantities of seasonal labor) have very similar educational attainment profiles.

Table 8.8, shows that Imperial County family income distribution is well within the normal ranges for California counties. The unrelated individual section, however, points out that all location quotients in this section for Imperial County are low. This means that unrelated individuals, as a group, represent a much smaller part of the Imperial County population than that group represents for the state as a whole and is additional evidence of the county's unrelated young outmigration. For those unrelated individuals who do remain in Imperial County, the income distribution is fairly typical.

In fact, the relative drop off in the number of unrelated individuals making over $15,000 per year is smaller in Imperial County than in many other California counties. Imperial County has high poverty level indicators for both families and unrelated individuals (the 0.805 location quotient for the poverty indicator for unrelated individuals must be weighed against the relatively low number of unrelated individuals

Table 8.8. Income and poverty indicator location quotients for California counties.

COUNTY \ INCOME LEVEL(K$)	FAMILIES							UNRELATED INDIVIDUALS			
	0-4	4-6	6-8	8-10	10-15	15-25	25-	0-4	4-6	6-8	8-10
ALAMEDA	0.920	0.853	0.908	0.992	1.069	1.059	0.881	1.222	1.178	1.137	1.318
ALPINE	1.398	0.975	1.476	0.726	1.002	0.801	0.946	0.341	1.043	0.	1.733
AMADOR	1.357	1.448	1.354	1.451	1.023	0.687	0.354	0.824	0.795	0.809	0.334
BUTTE	1.863	1.550	1.273	1.055	0.830	0.581	0.535	1.753	0.683	0.512	0.385
CALAVERAS	1.622	1.560	1.528	1.082	0.953	0.715	0.626	0.946	0.669	0.259	0.388
COLUSA	1.267	1.339	1.319	0.995	1.001	0.685	0.837	0.922	0.731	0.745	0.299
CONTRA COSTA	0.735	0.705	0.753	0.950	1.168	1.373	1.372	0.495	0.535	0.556	0.717
DEL NORTE	1.328	1.250	1.453	1.249	1.057	0.580	0.444	0.803	0.662	0.530	0.575
EL DORADO	1.338	1.327	1.241	1.247	1.073	0.802	0.667	0.402	1.143	0.586	0.850
FRESNO	1.527	1.388	1.177	1.045	0.841	0.646	0.610	0.909	0.616	0.464	0.405
GLENN	1.434	1.559	1.507	1.189	0.841	0.629	0.448	0.766	0.695	0.419	0.438
HUMBOLT	1.249	1.211	1.285	1.340	0.967	0.679	0.607	1.251	0.517	0.655	0.469
IMPERIAL	1.334	1.490	1.261	0.993	0.757	0.547	0.515	0.656	0.464	0.387	0.391
INYO	1.717	0.879	1.317	1.305	1.242	0.769	0.672	0.886	0.709	0.457	1.116
KERN	1.430	1.379	1.217	1.110	0.910	0.705	0.531	0.767	0.463	0.458	0.463
KINGS	1.631	1.722	1.480	0.959	0.723	0.408	0.337	1.140	0.578	0.474	0.347
LAKE	2.714	2.335	1.433	1.025	0.788	0.470	0.522	1.310	0.723	0.356	0.490
LASSEN	1.053	1.267	1.306	1.391	0.930	0.680	0.358	0.917	0.563	0.801	0.678
LOS ANGELES	0.950	0.954	0.992	0.990	0.992	1.036	1.174	0.965	1.166	1.208	1.222
MADERA	1.893	1.786	1.350	1.073	0.725	0.497	0.479	0.817	0.421	0.352	0.274
MARIN	0.558	0.637	0.636	0.719	0.973	1.485	2.263	0.802	0.979	1.068	1.268
MARIPOSA	1.708	1.932	1.508	1.110	0.927	0.541	0.109	1.375	1.311	1.335	0.737
MENDOCINO	1.455	1.340	1.242	1.200	0.974	0.655	0.463	1.006	0.668	0.614	0.509
MERCED	1.532	1.603	1.450	1.039	0.748	0.551	0.406	0.786	0.579	0.381	0.323
MODOC	1.738	1.820	1.047	1.407	0.970	0.623	0.490	0.761	0.954	0.553	0.417
MONO	1.187	0.844	0.996	1.154	1.342	0.777	0.537	0.972	1.257	0.895	1.402
MONTEREY	0.999	1.152	1.082	0.962	0.891	0.709	0.722	1.755	1.384	1.031	0.779
NAPA	1.061	0.969	0.932	0.982	1.128	0.939	0.732	0.982	0.699	0.657	0.672
NEVADA	1.663	1.696	1.607	1.317	0.953	0.651	0.410	0.613	0.690	0.726	0.618
ORANGE	0.647	0.740	0.805	0.939	1.132	1.305	1.193	0.571	0.699	0.746	0.761
PLACER	1.245	1.072	1.210	1.189	0.998	0.857	0.683	0.769	0.581	0.622	0.580
PLUMAS	1.123	1.176	1.403	1.359	1.222	0.671	0.793	0.874	0.717	1.091	0.440
RIVERSIDE	1.447	1.382	1.204	1.087	0.910	0.732	0.718	0.982	0.757	0.627	0.618
SACRAMENTO	0.969	1.034	1.070	1.103	1.053	1.002	0.784	0.763	0.751	0.787	0.750
SAN BENITO	1.228	1.290	1.319	1.143	0.843	0.589	0.660	0.772	0.498	0.487	0.546
SAN BERNARDINO	1.256	1.224	1.193	1.158	0.971	0.780	0.557	0.871	0.612	0.577	0.519
SAN DIEGO	1.019	1.118	1.046	0.999	0.949	0.850	0.783	1.663	1.319	1.059	0.886
SAN FRANCISCO	1.059	0.936	0.957	0.873	0.848	0.869	1.081	1.829	2.513	2.948	2.772
SAN JOAQUIN	1.288	1.129	1.097	1.160	1.013	0.730	0.680	1.028	0.674	0.594	0.581
SAN LUIS OBISBO	1.484	1.401	1.069	1.009	0.887	0.632	0.486	1.883	0.779	0.594	0.614
SAN MATEO	0.585	0.579	0.699	0.877	1.179	1.491	1.736	0.562	0.896	1.076	1.230
SANTA BARBARA	0.937	1.022	1.075	0.977	0.949	0.943	0.804	1.547	1.010	0.823	0.804
SANTA CLARA	0.624	0.668	0.776	0.884	1.088	1.322	1.164	0.723	0.714	0.817	0.904
SANTA CRUZ	1.541	1.392	1.158	1.046	0.913	0.807	0.724	1.529	1.063	0.626	0.671
SHASTA	1.467	1.273	1.286	1.233	1.048	0.696	0.486	0.754	0.479	0.560	0.370
SIERRA	1.462	1.594	1.945	0.815	0.949	0.871	0.707	1.141	0.736	0.231	1.191
SISKIYOU	1.328	1.268	1.516	1.429	1.033	0.608	0.517	1.000	0.627	0.717	0.547
SOLANO	1.080	1.204	1.131	1.101	1.040	0.831	0.501	1.020	0.777	0.695	0.704
SONOMA	1.393	1.224	1.037	1.087	1.042	0.790	0.635	1.033	0.685	0.566	0.633
STANISLAUS	1.540	1.450	1.279	1.102	0.929	0.647	0.669	0.796	0.485	0.506	0.420
SUTTER	1.323	1.422	1.236	1.105	0.952	0.809	0.714	0.568	0.597	0.463	0.451
TEHAMA	1.496	1.469	1.548	1.317	0.915	0.646	0.414	0.861	0.383	0.495	0.459
TRINITY	1.658	1.211	1.318	1.682	1.040	0.420	0.421	0.936	0.911	0.472	0.865
TULARE	1.681	1.735	1.287	1.024	0.767	0.519	0.472	0.724	0.483	0.339	0.340
TUOLUMNE	1.451	1.221	1.416	1.136	1.050	0.756	0.510	0.963	0.455	0.583	0.595
VENTURA	0.825	0.862	0.906	0.971	1.078	1.045	0.768	0.620	0.566	0.552	0.560
YOLO	1.178	1.009	1.195	1.085	0.879	0.752	0.689	1.905	0.776	0.582	0.621
YUBA	1.647	1.837	1.644	0.988	0.638	0.454	0.297	1.105	0.712	0.650	0.372

Table 8.8. (Concluded)

COUNTY \ INCOME LEVEL(K$)	10-15	15-	POVERTY INDICATORS FAMILY	INDIVIDUAL
ALAMEDA	1.208	1.008	0.957	1.271
ALPINE	1.412	0.0	1.077	0.605
AMADOR	0.530	0.748	1.078	1.013
BUTTE	0.344	0.292	1.431	2.044
CALAVERAS	0.512	0.558	1.224	1.215
COLUSA	0.559	0.354	1.162	1.123
CONTRA COSTA	0.843	0.754	0.778	0.524
DEL NORTE	0.398	0.399	1.264	0.950
EL DORADO	0.613	0.294	1.204	1.059
FRESNO	0.407	0.428	1.665	1.074
GLENN	0.299	0.476	1.282	0.811
HUMBOLT	0.542	0.345	1.184	1.577
IMPERIAL	0.310	0.343	1.769	0.605
INYO	0.797	0.552	1.047	0.917
KERN	0.519	0.448	1.514	0.862
KINGS	0.300	0.287	1.818	0.718
LAKE	0.268	0.582	2.159	1.562
LASSEN	0.583	0.211	0.747	1.109
LOS ANGELES	1.205	1.310	0.973	1.036
MADERA	0.192	0.316	1.927	1.161
MARIN	1.627	2.094	0.542	0.825
MARIPOSA	0.095	0.672	1.473	1.520
MENDOCINO	0.479	0.495	1.413	1.330
MERCED	0.335	0.273	1.622	0.792
MODOC	0.259	0.169	1.376	0.745
MONO	1.362	0.377	1.345	1.050
MONTEREY	0.943	0.824	1.041	0.834
NAPA	0.589	0.483	0.949	1.008
NEVADA	0.506	0.632	1.318	1.185
ORANGE	0.840	0.883	0.621	0.577
PLACER	0.659	0.422	1.172	0.962
PLUMAS	0.701	0.259	1.105	1.053
RIVERSIDE	0.618	0.605	1.320	1.039
SACRAMENTO	0.715	0.634	0.991	0.831
SAN BENITO	0.613	0.395	1.222	0.950
SAN BERNARDINO	0.495	0.401	1.193	0.818
SAN DIEGO	0.841	0.861	0.984	0.891
SAN FRANCISCO	2.429	2.304	1.091	1.982
SAN JOAQUIN	0.511	0.455	1.335	1.113
SAN LUIS OBISBO	0.542	0.464	1.240	1.759
SAN MATEO	1.389	1.215	0.524	0.640
SANTA BARBARA	0.824	0.855	0.873	1.584
SANTA CLARA	1.090	0.970	0.952	0.785
SANTA CRUZ	0.685	0.531	1.318	1.848
SHASTA	0.442	0.413	1.381	0.905
SIERRA	0.394	1.569	1.200	1.684
SISKIYOU	0.360	0.220	1.132	1.294
SOLANO	0.735	0.358	1.088	0.763
SONOMA	0.569	0.454	1.277	1.397
STANISLAUS	0.453	0.408	1.462	0.980
SUTTER	0.570	0.265	1.123	0.622
TEHAMA	0.371	0.229	1.306	1.191
TRINITY	0.539	0.431	1.219	1.238
TULARE	0.290	0.305	1.769	0.800
TUOLUMNE	0.433	0.217	1.195	1.138
VENTURA	0.623	0.532	0.940	0.670
YOLO	0.607	0.493	1.195	2.034
YUBA	0.410	0.333	1.739	0.936

in the county), but such statistics must be viewed in light of the large number of migrant and seasonal farm workers employed in Imperial County. Most of the poverty is concentrated in this group rather than spread across a large number of job classes. Poverty is a problem in Imperial County, but it is certainly not a unique problem to the county in either its existence or magnitude.

8.2 INTRACOUNTY SOCIOLOGICAL DESCRIPTION

INTRACOUNTY POPULATIONS

Census survey data are available for urban populations every 10 years. Census data also covers some unincorporated areas with populations over 1000 and populations of several rural county census divisions. However these figures do not include specific populations of any of Imperial County's smaller and unincorporated communities. Some estimates for these populations have been obtained from personal interviews, from data from the State Department of Finance, and from basic census data interpolation. The resultant data from all of these sources are shown in Table 8.9 All areas listed below Calipatria are estimates, whereas all data for Calipatria and above represent official census or State Department of Finance data. The term, total municipal population, indicates the total population living in all incorporated and unincorporated towns. Rural populations are those outside town boundaries. Total Imperial Valley population was obtained by including appropriate rural county census divisions for 1960 and 1970 with Imperial Valley municipal populations. The area of most rapid increase within the county in recent years has been the Imperial-Calexico axis. Note that urban related populations are increasing relative to rural populations. Both the percentage of county populations and number of individuals representing rural population are decreasing.

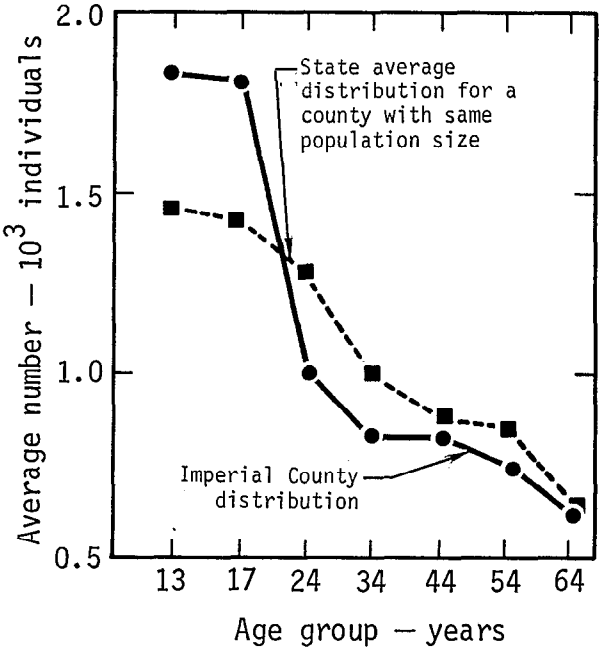

Fig. 8.1. Imperial County population distribution as a function of age. Numbers in the ordinate indicate maximum age in group, i.e., 34 means ages 24 to 34.[1]

Table 8.9. Imperial County intracounty population distribution 1950 to 1974.[1]

Community	Population 1950	1960	1970	1974	% Change 1950-1974
El Centro	12,590	16,811	19,272	21,300	+69.2
Imperial	1,759	2,658	3,094	3,210	+82.5
Calexico	6,443	7,992	10,625	12,829	+99.1
Brawley	11,922	12,703	13,746	13,940	+16.9
Holtville	2,472	3,080	3,496	3,580	+44.8
Westmorland	1,010	1,404	1,175	1,407	+39.3
Calipatria	1,428	1,848	1,824	1,890	+32.4
Niland		900	1,050	1,137	
Heber		1,700	1,850	2,206	
Seeley		700	900	1,024	
Plaster City		50	80	86	
Ocotillo		200	200	233	
Palo Verde		300	350	440	
Winterhaven-Band		1,973	2,060	2,142	
Other non valley rural		1,551	1,157	1,430	
Imperial Valley rural		18,235	13,613	16,822	
Total municipal population		52,319	59,722	65,424	
Total county population	62,516	72,105	74,492	83,676	+33.9
Total rural population		19,786	14,770	18,252	
% rural population		27.4%	19.8%	21.8%	
Total Imperial Valley population		66,508	70,645	79,345	
% of Total population in Imperial Valley		92.2%	94.7%	94.8%	

REFERENCES

1. United States Department of Commerce, Bureau of the Census, *1970 Census Survey for California Counties.*
2. J.E. Pick, *Population and Economic Statistics for Imperial County 1950-1970,* unpublished draft report, U.C. Riverside (April, 1976).

Section 9
Geothermal Laws

Jim Wharton and David Layton

9.1 INTRODUCTION

Development of geothermal resources in the Imperial Valley is guided by a series of statutes and regulations passed by the federal government, the State of California, and Imperial County. Although these laws apply in an overlapping manner, the primary law that applies to the development of geothermal resources depends on whether the land is private, federal, or state property. This section describes some of the important statutes and regulations that control geothermal development.

9.2 FEDERAL LAW ON GEOTHERMAL RESOURCES

The two major federal laws that apply to geothermal resources in the Imperial Valley are the Geothermal Steam Act of 1970[1] and the Geothermal Energy Research, Development, and Demonstration Act of 1974.[2]

Federal Leases

Federal laws existing before 1970 did not provide for the development of geothermal steam. The legislative history[3] of the 1970 Act indicates that the intent of Congress was to provide statutory authority for the Secretary of the Interior to issue leases for the development of geothermal steam and the associated geothermal steam resources underlying public lands in much the same manner as he was authorized to lease land for development of oil and gas deposits under the Mineral Leasing Act of 1920, as amended.[4] The definitions under the mineral leasing laws were amended to include geothermal resources:

> "Mineral leasing laws shall mean the Geothermal Steam Act of 1970 which are amendatory of or supplementary to any of the foregoing Acts; Leasing Act minerals shall mean all minerals which are provided in the mineral leasing laws and all geothermal steam and associated geothermal resources which, upon the effective date of the Geothermal Steam Act of 1970, are provided in that Act to be disposed of thereunder."[5]

The lands subject to geothermal leasing are specified in the Geothermal Steam Act. They consist of public, withdrawn, and acquired lands administered by the Forest Service in a national forest or other areas. Lands conveyed by the United States that are subject to a reservation of geothermal steam and associated resources are also available for leasing.[6] The actual leasing of lands

that are within a KGRA is done under a competitive bidding process as described in section 1003. A lease for such lands is awarded to the highest qualified bidder. Competitive bidding is not required when the lands to be leased are not in a KGRA. In that situation the lease is granted to the first qualified lease applicant.

Section 1003 further provides for the conversion rights of leases under the Mineral Leasing Act of Acquired Lands.[7] According to the Act, no person can convert more than 10,240 acres of mineral leases, permits, applications, or mining claims. Conversion to a geothermal lease may only occur when an individual has shown, to the satisfaction of the Secretary of the Interior, that substantial expenditures have been made for exploration, development, or production "on the lands for which a lease is sought or on adjoining, adjacent, or nearby Federal or non-Federal lands".[7]

Other lands open to competitive bidding are those that are within a KGRA and are subject to a right to conversion provided that,

> "the competitive geothermal lease shall be issued to the person owning the right to conversion to a geothermal lease if he makes payment for an amount equal to the highest bona fide bid for the competitive geothermal lease, plus the rental for the first year, within thirty days after he receives written notice from the Secretary of the amount of the highest bid."[7]

Restrictions on lease acreage and exemptions of certain federal lands are contained in Sections 1006 and 1014, respectively. Section 1006 limits a geothermal lease to 2,560 acres except where there are irregular subdivisions. Moreover, it restricts for most cases the total acreage a lessee can have in a particular state to 20,480 acres. Federal lands exempt from geothermal leasing under section 1014 include lands within a national recreation area, lands in a fish hatchery administered by the Secretary of the Interior, wildlife refuge, wildlife range, game range, wildlife management area, waterfowl production area, or lands acquired or reserved for the preservation of fish or wildlife threatened with extinction.

Federal Regulations

The Department of the Interior has promulgated federal regulations that govern geothermal exploration and development activities related to leases granted under the Geothermal Steam Act. The rules governing geothermal leases give particular attention to environmental protection. Geothermal Resources Operational Order (GRO) No. 4, for instance, states that a lessee must:

> "Conduct exploration and development operations in

a manner that provides maximum protection of the environment; rehabilitate disturbed lands; take all necessary precautions to protect the public health and safety; and conduct operations in accordance with the spirit and objectives of all applicable Federal environmental legislation and supporting executive orders."[8]

More specifically, GRO No. 4 requires a lessee to reclaim disturbed lands, reduce erosion, protect fish, wildlife, and their habitats, monitor subsidence and seismicity, comply with all applicable pollution control standards, and minimize noise. These and other conditions in the order are enforced by an Area Geothermal Supervisor, who has authority to suspend operations on a lease that is in violation of regulations.

Federal Geothermal Loan Guaranty Program

The Congress has established a loan guaranty program[9] to encourage and assist in the commercial development of useful energy from geothermal resources by environmentally acceptable processes. The guaranty protects lenders against loss of principal or interest on loans made for the purposes of:

- The determination and evaluation of the resource base,
- research and development with respect to extraction and utilization technologies,
- acquisition of rights in geothermal resources, or
- development, construction, and operation of facilities for the demonstration or commercial production of energy from geothermal resources.

The amount of guaranty is limited to 75% of the aggregate cost of the project with respect to which the loan is made. In addition, the amount of the guaranty for any loan for a project shall not exceed $25,000,000, and the amount of the guaranty for any combination of loans for any single qualified borrower shall not exceed $50,000,000.

A qualified borrower is any public or private agency, institution, association, partnership, corporation, political subdivision, or other legal entity that has presented satisfactory evidence of an interest in geothermal resources and is capable of performing research or completing the development and production of energy in an acceptable manner.

Any activities to develop geothermal resources shall place particular emphasis upon the objective of assuring that the environment and the safety of persons or property are effectively protected. All of the research, development, and demonstration functions, including the loan guaranty program, are vested in the

Energy Research and Development Administration.

Federal Licenses and Permits

A possible area of federal control over geothermal power plants comes under the Federal Power Act. Although the Act applies generally to hydroelectric plants, the Federal Power Commission is authorized to regulate the interstate sales of electricity.[10] Thus, any geothermal power transported out of the Imperial Valley to some other state would require prior approval by the commission. The Federal Power Commission does not have the power to license use of surplus water by thermal electric plants.[11]

The Corps of Engineers issues two permits that could be required by geothermal plants in the valley. A construction permit under section 10 of the 1899 Rivers and Harbors Act is required to build any structure in navigable waters,[12] and a permit is needed to discharge refuse into certain waters under Section 13 of the same act.[13] The corps, before issuing a permit, accepts the Environmental Protection Agency's (EPA) findings with respect to applicable water standards.[14] The EPA transmits applications to state agencies near the facility.[15] Without a section 21 (b)[16] certificate on the impact on water quality, a permit cannot be issued by the corps. Besides these water quality regulations, the EPA has other regulations dealing with air pollution from new power plants.[17]

9.3 CALIFORNIA STATE LAWS ON GEOTHERMAL RESOURCES

The State of California has several laws and regulations that will control geothermal development in the Imperial Valley. The main laws are the state geothermal lease laws, the state regulations of geothermal wells, and laws governing power plants siting.

State Geothermal Leases

The issuance of leases for California state lands is generally controlled by statutes given in the California Public Resources Code section 6902 et seq.[18] Leases for geothermal extraction and removal are issued by the State Lands Commission. State lands are defined as "all lands owned by the state, including school lands, proprietary lands, tidelands, submerged lands, swamp and overflowed lands, and beds of navigable rivers and lakes, and lands in which geothermal resources have been reserved to the state."[19]

A lease application must be for at least 640 acres but not more than 2,560 acres of reasonably compact area.[20] A permit or lease, however,

may be issued for less than 640 acres if the parcel is separated from other parcels of land available for permit or lease.[21] Section 6908 of the Public Resources Code also prohibits a person, association, or corporation from controlling directly or indirectly more than 25,600 acres of state geothermal leases. Competitive bidding is allowed on those lands that are classified as known geothermal resource areas, i.e., those areas that contain at least one well capable of producing geothermal resources in commercial quantities or are designated by the commission on the recommendation of the Geothermal Resources Board. The bidding is regulated by the State Lands Commission.

Statutes on Geothermal Wells

The interest of the State of California in the drilling of geothermal wells is contained in the California Public Resources Code section 3700 et seq.[22] The state's primary concern is "that wells for the discovery and production of geothermal resources be drilled, operated, maintained, and abandoned in such manner as to safeguard life, health, property, and the public welfare, and to encourage maximum economic recovery".[22]

The following statutes from the California Public Resources Code provide for orderly development of geothermal resources, encourage the greatest possible economic recovery, and delegate to the State Oil and Gas Supervisor the power to protect the environment:

Section 3714

"The State Oil and Gas Supervisor shall so supervise the drilling, operation, maintenance and abandonment of geothermal resources wells as to encourage the greatest ultimate economic recovery of geothermal resources,.... and to prevent damage to underground and surface waters suitable for irrigation or domestic purposes by reason of the drilling, operation, maintenance, and abandonment of geothermal resources wells."

Section 3715

"The supervisor shall also supervise the drilling, operation, maintenance, and abandonment of wells so as to permit the owners or operators of such wells to utilize all methods and practices known to the industry for the purpose of increasing the ultimate recovery of geothermal resources. . . . . ."

Section 3724.1

"An owner or operator may submit to the supervisor for approval a written program to drill a shallow well or wells for geothermal observation purposes. In order to qualify under this section, a program shall contain not more than 25 wells and the maximum total depth of each of these wells shall not exceed 250 feet."

Section 3725

"Every person who engages in the drilling, redrilling, or deepening of any well shall file with the supervisor an indemnity bond in the sum of five thousand dollars ($5,000) for each well drilled, redrilled, or deepened.

Section 3730

"The owner or operator of any well shall keep, or cause to be kept, a careful and accurate log, core record, and history of the drilling of the well."

Section 3739

"Any person engaged in operating any wells wherein high pressures are known to exist, and any person drilling for geothermal resources in any district where the pressures are unknown shall equip the well with casings of sufficient strength, and with such other safety devices as may be necessary, in accordance with methods approved by the supervisor, and shall use every reasonable effort and endeavor effectually to prevent blow outs, explosions, and fires."

California Regulation of Geothermal Wells

State regulations as contained in the California Administrative Code are particularly concerned with blowout prevention, developmental wells, maintenance of drilling logs, and protection of the environment. These regulations are contained in Title 14 of the California Administrative Code.[23] The general policy in drilling wells is to protect or minimize damages to the environment, usable ground waters, geothermal resources, life, health, and property. The regulations prescribe the notice requirements of the owner or operator of a geothermal resource. The fees and bonds are given. In addition, requirements for well spacing, casing, construction of conductor pipe, mud return temperatures, and blowout-prevention equipment are contained in the regulations.

A log must be kept containing core records and a history of the drilling of the well. The history must describe in detail, in chronological order, and on a daily basis all significant operations carried out and equipment used during all phases of drilling, testing, completion, recompletion, and abandonment of the well. A summary report must accompany the core record and well history, showing data pertinent to the condition of a well at the time of completion of work done. Monthly production records must be filed with the supervisor on the 10th day of each month. Also, injection records must be filed with the superviosr.

The Administrative Code contains regulations pertinent to the subsidence that might occur in the

Imperial Valley. These regulations are concerned with procedures for surveying and installing benchmarks for the detection of subsidence. The wells to be drilled must have benchmarks that tie into existing first or second order subsidence networks. Surveying must be coordinated with the County Surveyor and the actual work conducted under the supervision of a Registered Civil Engineer or Licensed Land Surveyor. Benchmarks must occur at accepted intervals and surveys of the benchmarks must be run annually at the expense of the operator while the well(s) are in production.[24]

Geothermal Powerplant Siting

Powerplants operated by geothermal fluids will be licensed by the California Energy Resources Conservation and Development Commission. The energy commission has exclusive power to certify all powerplant sites and related facilities (e.g., transmission lines). Section 25500 of California Public Resources Code states that "the issuance of a certificate by the commission shall be in lieu of any permit, certificate, or similar document required by any state, local or regional agency, or federal agency to the extent permitted by federal law...."[25] However, there is still a Certificate of Public Convenience needed from the Public Utilities Commission.[26]

Areas prohibited as powerplant sites are parks, wilderness, scenic or natural reserves, and areas for wildlife protection, recreation, or historic preservation.[27] An applicant may be required to obtain development rights in the area of a proposed site so that local population densities can be controlled.[28] In addition, a special monitoring system, to be run by the commission in cooperation with other state and local agencies, must be used to verify compliance with the applicable environmental regulations.[29]

Section 25540 specifically exempts an applicant from analyzing 3 alternative sites for a proposed geothermal energy facility. Under section 25541 of the Code a powerplant under 100 MW (including a geothermal plant) may be exempted from the certification process if the commission finds that:

- "No substantial adverse impact on the environment or energy resources will result from the construction or operation of the proposed facility or from modification", and
- "Generating capacity will not be added which is substantially in excess of the forecast of electrical energy demands..." [30]

If the powerplant is below 50 MW, the Energy Conservation and Development Act does not apply.

9.4 LOCAL LAWS OF IMPERIAL COUNTY

Additional regulations affecting geothermal activities in the valley have been adopted by Imperial County. Those regulations are described in the document, "Terms, Conditions, Standards, and Application Procedures for Initial Geothermal Development, Imperial County," which was issued in May of 1971 by the Department of Public Works. The terms and conditions are designed to encourage the orderly development of initial geothermal facilities, but are only interim in nature because a more comprehensive plan dealing with geothermal resources is being developed.

The regulations stipulate, among other things, that geothermal operators must comply with all appropriate local, state, and federal laws during the different phases of exploration and development. Furthermore, operators of a geothermal production project must monitor subsidence, minimize noise, preserve farm land, and abandon project sites according to prescribed procedures. Zoning ordinances are another form of county regulation. Production projects may only develop geothermal resources within areas specified by the County Planning Commission.

BKI/gw/vt

REFERENCES

1. 30 United States Code, Sec. 1001 et seq.
2. 30 United States Code, Sec. 1101 et seq.
3. Interior and Insular Affairs Committee, House Report No. 19-1544, 91st. Congress, 2nd. Session (1970); 3 U.S. Congressional and Administrative News, 5113 (1970).
4. 30 United States Code, Sec. 181 et seq.
5. 30 United States Code, Sec. 530.
6. 30 United States Code, Sec. 1002.
7. 30 United States Code, Sec. 1003.
8. United Stated Department of the Interior, Geological Survey, Geothermal Resources Operational Orders, January, 1976.
9. 30 United States Code, Sec. 1411-1144.
10. 16 United States Code, Sec. 796.
11. Chemehuevi Tribe of Indians V. Federal Power Commission, 955 S. Ct. 1066, Dist. Col. 1975.
12. 33 United States Code, Sec. 403 (1970).
13. 33 United States Code, Sec. 407 (1970).
14. Executive order 11574, 2(a) (2A), 3c, F, R, 556 (1971).
15. Water Pollution Control Act section 21(b), 33 United States Code, Sec. 1171(b) (1970).
16. See Note 15, above.
17. 42 United States Code, Sec. 1857C-6(b) (1970).
18. West's California Public Resources Code, Sec. 6902 et seq.
19. West's California Public Resources Code, Sec. 6904.
20. West's California Public Resources Code, Sec. 6908.
21. West's California Public Resources Code, Sec. 3700 et seq.
22. Id. Sec. 3700.
23. California Administrative Code, Title 14, Sec. 1900 et seq.
24. Id. Sec. 1971.
25. West's California Public Resources Code, Sec. 25500.
26. West's California Public Utilities Code, Sec. 1001; West's California Public Resources Code, Sec. 25518.5.
27. West's California Public Resources Code, Sec. 25527.
28. Id. Sec. 25528.
29. Id. Sec. 25522.
30. Id. Sec. 25120.